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PRECANCEROUS AND CARCINOID LESIONS OF THE CERVIX UTERI

WITH COMMENTS ON THE SCHILLER TEST

ERLE HENRIKSEN, M.D., BALTIMORE, MARYLAND

From the Gynecological Department of the Johns Hopkins Hospital and University

IN the great majority of cases, the diagnosis of carcinoma is simple enough, either clinically or pathologically, and microscopic examination is only confirmatory. In the early and "borderline" cases, however, the microscope must play the decisive rôle. To wage an effective fight against cancer, moreover, we must not only be familiar with the characteristics of early cancer, but we must learn something more about lesions now loosely spoken of as "precancerous." This term was first used by Dubreuilh in 1896 and has been widely adopted. It is undoubtedly a good descriptive term if applied, as it should be, only to those processes which may, but do not necessarily, become malignant. It should not be construed as indicating that the lesion in question represents the preliminary stages of cancer, though it is quite possible that some of them do. As long as we do not know the cause of cancer, a study of these lesions and of their possibly malignant potentialities offers a new and fertile field for the gynecological pathologist and may be expected to yield much in the way of early treatment and prophylaxis of cancer.

We have recently completed a study of material from the cervices of 50 individuals who have been treated conservatively in our department, in an endeavor to correlate as accurately as possible the histological picture and the subsequent clinical course. Microscopically the cervices all showed evidence of increased cellular activity, i.e., mitoses, hyperchromatosis, polymorphia, and hyperplasia of the basal layer; without, however, any evidence of invasion. Indeed, all the cytological characteristics of cancer were in evidence, except epithelial heterotopia. Recent examinations have shown, in spite of the cancer-like cell changes in the original lesions, no tendency to the subsequent development of cancer.

Normal cervix. The accepted description of the normal histological picture of the cervix varies so markedly that it is difficult to obtain sections of the epithelium conforming to the textbook descriptions. The distinction between the three accepted strata is definite. The basal layer has a picket-fence appearance with an undisturbed nuclear polarity. Mitoses and hyperchromatosis are more frequently present than most observers have noted, but these are merely suggestive of expected natural cellular changes necessary for the processes of growth and repair.

The thickness of the epithelial layer is apparently independent of the age of the adult patient, and we have noticed no constant histological changes in the pregnant cervix. Inflammatory processes seem to alter the basal layer, bringing about an apparently increased cellular activity. Hot douches, cauterizations, and local therapy also produce a distorted histological picture (Fig. 2).

Metaplasia. The value of serial sections of biopsy material is fully demonstrated in cases of so called "metaplasia" or "epidermization." Though in some instances the cytological changes resulting from the inflammatory lesions do present a perplexing picture, the cellular activity in some of the chronically infected cervices has frequently led to erroneous interpretations, and probably accounts for some so called 5 year cures. In most instances the benign invasion by the squamous epithelium is innocuous in appearance and in no way resembles the ruthless invasion of the malignant growth. Cell nests and columns of squamous cells (Fig. 3), apparently lying free of surface attachment, may tend to confuse the picture. A full appreciation of the mechanism of this process simplifies its interpretation and lessens the probability of errors in diagnosis. The individual cells in most instances display none of the characteristic cytological features associated with malignancy. The round cell infiltration is also less marked, though this reaction is far from dependable. Mitoses and hyperchromatosis are not uncommon and not infrequently the changes are so marked as to suggest a cancerous process.

That in the majority of cases so called metaplasia is not a percursor of cancer is accepted. However, the presence of this process does imply a chronic irritation and conservative corrective therapy is indicated. Without doubt a few of these lesions do develop into malignant processes, but it is not possible with our present information to differentiate the ones that will remain benign from those possessing malignant potentialities.

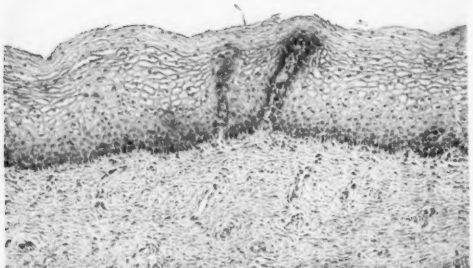

Fig. 1. From a 19 year old nullipara (Plate 1, Fig. 1). The three strata are well defined and the basal line is intact with equal nuclear polarity. No stromal reaction.

Leucoplacia. Hinselmann's work with the colposcope has revived our interest in the leucoplacia-like changes in the cervical epithelium and has also created a new field for possible diagnostic errors. Simple curetting of the cervix for microscopical study, as originally suggested by Schiller, does not yield sufficient tissue for the diagnosis of this process, as the individual cellular changes may too closely simulate the cells of cancer. Again, the value of serial sectioning of biopsy specimen is to be emphasized.

The process develops most frequently at the site of transition between the squamous and columnar epithelium, though it is not rare to find the entire cervix sprinkled (Plate I, Fig. 6) with the small white or grayish-white plaques. Microscopically the epithelium is more compact and varies in thickness. There is decided basal layer hyperplasia with changes in the nuclear polarity. Mitoses may be of both the normal and the pathological types, though they may be very sparse. The subepithelial round cell response also varies and may at times be entirely lacking. We have not noticed the subepithelial hyalinization which is so commonly seen in leucoplacic processes elsewhere. In those cases with marked stromal reaction it is frequently difficult to trace the basal line and the presence of invasive tendencies may be simulated. As Schiller has shown, there is usually a sharp transition from the normal epithelium to the area of leucoplacia. This line of demarcation is also prominent in other conditions, as we shall describe later. Leucoplacia elsewhere is considered genuinely a precancerous lesion, but whether this applies to the cervix is certainly debatable; the histological criterion accepted by some include changes characteristic of definite malignancy, except that invasion is not present. Several observers claim to have observed cases in which cancer has developed within an area previously shown to be leucoplacic. We have not been fortunate enough to encounter any similar instances.

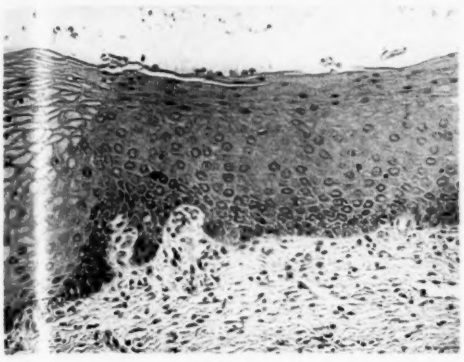

Fig. 2.

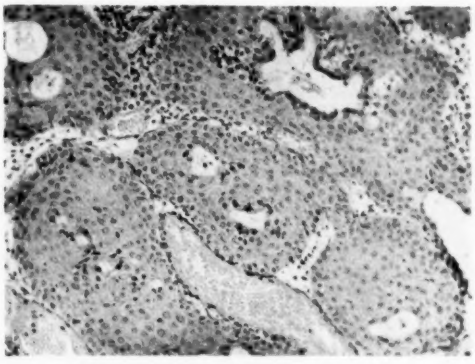

Fig. 3.

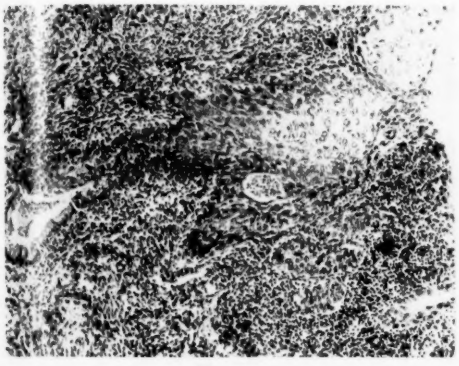

Fig. 4.

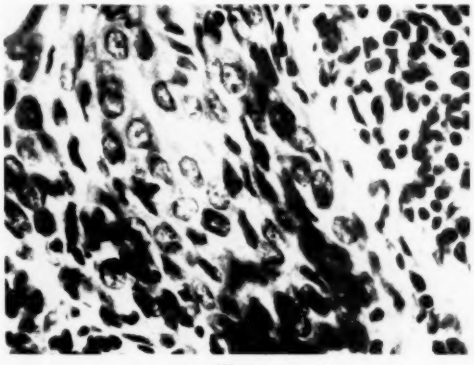

Fig. 5.

Fig. 2. An unusual abrupt change between the loosely packed squamous layer on one side and a more compact layer; this differs from the transitional line in certain other conditions in that it is vertical. This patient had received a prolonged course of local therapy to the cervix.

Fig. 3. Benign epidermization with nests of squamous cells, rare mitoses, and no suggestion of malignancy.

Fig. 4. The epidermization process has replaced the cylindrical elements in an orderly fashion, except at one point there is an apparent break in the basal membrane.

Fig. 5. High power of Figure 4 showing increased cellular activity with mitoses, many hyperchromatic nuclei, and no definite limiting layer. Six years after this biopsy was taken the patient shows no evidence of cancer.

However, we do believe that the present evidence is insufficient to place this lesion in the same class, as regards cancer potentiality, with the leucoplacia found elsewhere.

Carcinoma. Whether or not the metaplastic and leucoplacic processes of the cervix are likely to develop into true cancer is undecided. And yet we do not feel justified in permitting certain lesions to remain untreated because of scientific interest in their future course. The following case shows that carcinoma, here a basal cell type, may develop in metaplastic area.

The cervix (Plate I, Fig. 3) was deeply lacerated, with a duck-bill appearance; three small plaques were present just within what was formerly the external os. Following the application of the iodine solution, the two plaques on the anterior lip showed some absorption of the iodine and, microscopically, a local epithelial hypertrophy. The small plaque on the posterior lip, however, did not absorb the iodine and stood out sharply against the mahogany background. Biopsy was not performed, as an interposition operation with cervical amputation was indicated. Serial sections through the posterior lip showed a small malignant growth measuring 1 millimeter in diameter and originating in an area

Fig. 6. Changes in the cervical canal depicting the columnar elements replaced by squamous cells. Beneath the pale, normal appearing cells is noted the increasingly broad layer of darker stained cells; this layer supplants the paler cells entirely and assumes an appearance suggesting cancerous activity.

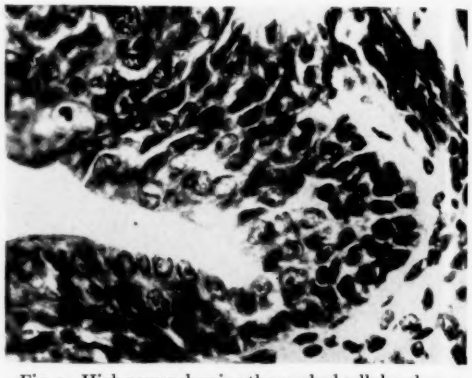

Fig. 7. High power showing the marked cellular changes. Mitoses and hyperchromatosis are frequent. This patient shows no evidence of cancer after a period of 18 months has elapsed.

of definite metaplasia. This patient is being examined each month and as yet has shown no tendency to recurrence.

Other interesting cervical lesions. So far as we know the microscopical cervical changes in the 2 following cases have received little or no attention in the literature. In 1912, Bowen described similar changes in the skin in an article titled, "Precancerous Dermatoses; Chronic Atypical Epithelial Proliferation," and the skin lesion described is accepted by most dermatologists as Bowen's disease. The acceptance of this as a nosological entity from the standpoint of etiology and pathogenesis is still debated, as is its relationship to the so called extramammary Paget's disease. Though the histological changes in our cases do not altogether fulfill the cytological criteria specified by Bowen, Darier, Jessner, and others, the similarity is striking enough to bear comparison.

CASE 1. (Plate I, Fig. 2.) In October, 1933, a 24 year old negress was examined for vaginal bleeding, later found to be the result of endometrial hyperplasia. Inspection of the cervix revealed a small cyst-like area on the anterior lip suggestive of an

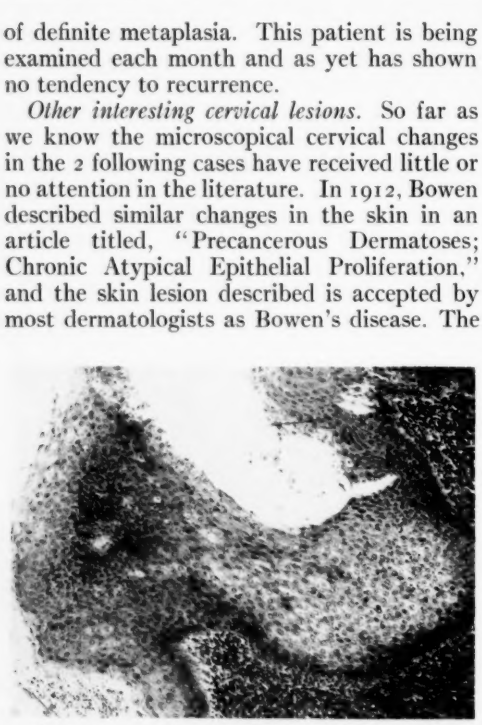

Fig. 8. Biopsy from a cervix of a 45 year old woman with procidentia of 2 years' standing. Marked thickening of the squamous layer with metaplasia. The basal layer shows definite hyperplasia, increased compactness of the strata, and increased cellular activity, with abundant stromal infiltration.

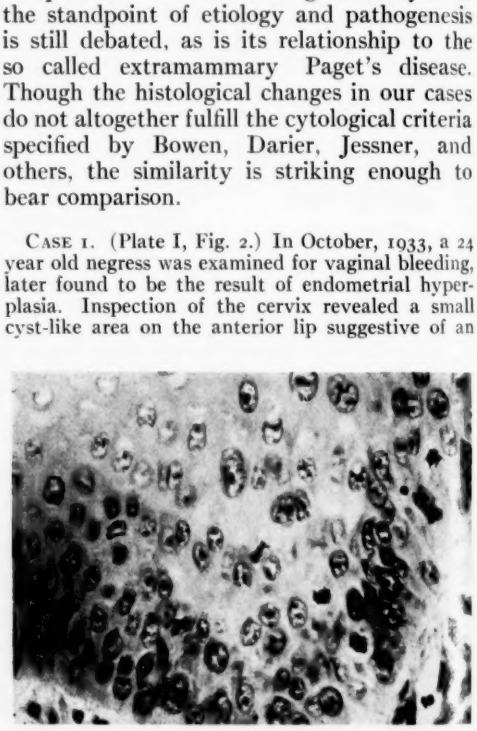

Fig. 9. Higher power showing atypical mitoses with polymorphia and hyperchromatosis. The cervix was amputated following an interposition operation and 4 years after this operation had been performed there is no change present which might be regarded as suggestive of cancer.

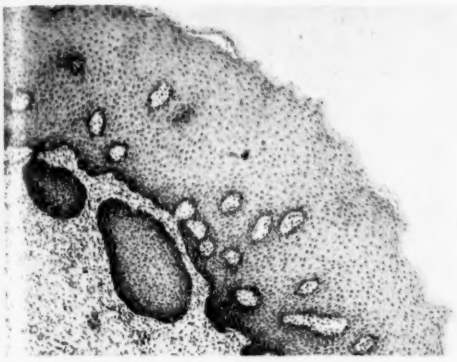

Fig. 10. A specimen removed from the anterior lip of the cervix in 1929. There is no evidence of cancer on recent examination. This is definitely of the leucoplacic group, showing epidermal thickening, increased compactness of the basal and transitional layers. Several small epidermal buds seemingly lying free of surface attachments are the result of angular sectioning. There is no evidence of invasion.

ordinary nabothian cyst. However, the iodine was not absorbed as readily as expected and the biopsy showed changes suggesting early malignancy, with perplexing cellular changes. Radical measures were deemed unnecessary, as it was thought that the entire growth was included in the biopsy. The location of the area was also considered to speak against malignant growth, as the accepted site of predilection for both cancer and leucoplacia is near the external os, or at the junction of the squamous and columnar cell layers.

This case is being carefully watched in our outpatient department and at a recent examination shows no recurrence of the white areas, and the cervix has always readily absorbed the iodine.

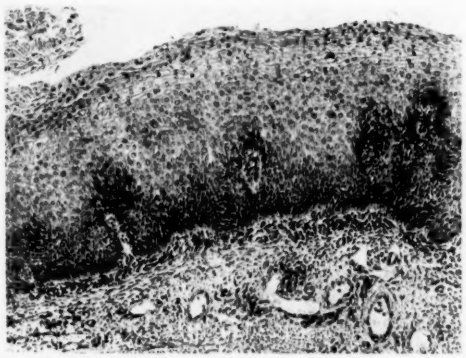

Fig. 12. Section of a polyp removed in 1929 showing marked basal hyperplasia with all the cellular changes characteristic of cancer. However, invasion has not taken place.

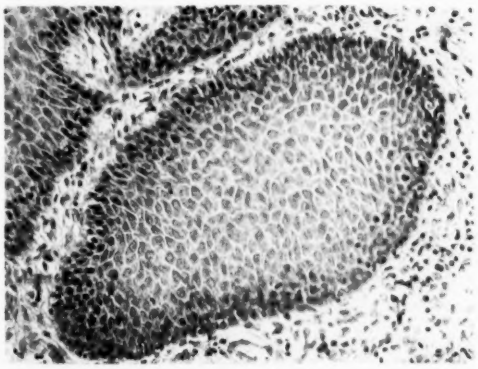

Fig. 11. High power of the epidermal bud shows many mitotic figures; however, the entire picture is that of a benign process with increased cellular activity.

CASE 2. There is no evidence of invasion in either of these cases. The relative lack of stromal reaction, with the œdema and hyalinization in the second case, removes this lesion from the category of accepted cancer. The true nature of this lesion is not known; are we dealing with an unusual form of cancer or of leucoplacia, or a pro-cancer with a new pathological and clinical entity? Two cases are not enough to warrant conclusions as to their true etiology or pathogenesis. We are following with interest the first case, which was treated conservatively, but unfortunately a panhysterectomy was performed on the second case.

Intracervical carcinoma. Though not an instance of early malignancy, we have included the following case not only to illustrate the value of the Schiller test in some cases, but

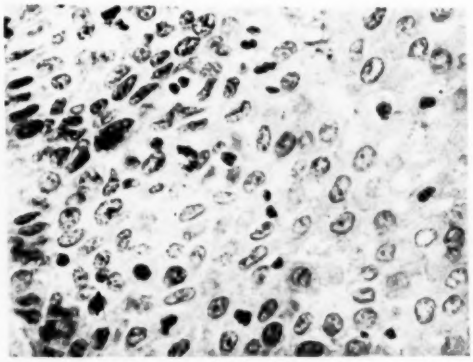

Fig. 13. High power showing both normal and pathological mitoses. There is also a moderate polymorphia. The stromal reaction is not marked. The patient on recent examination shows no tendency to cervical cancer.

Fig. 14. The line of transition between the squamous cells in the more normal epithelium and the carcinomatous area is sharp and clearly demonstrates the mode of malignant extension.

also because of the unusual nature of the malignant extension.

CASE EE. A 60 year old negress was registered with the complaint of vaginal bleeding of 3 weeks' duration. At examination there was no apparent bleeding and the pelvis was essentially of the normal senile type. On inspection, the cervix was found to be smooth and firm, with a wide velvet-red margin about the external os, which did not bleed following manipulation. This was interpreted as a typical erosion. A cotton swab passed up into the cervical canal did not elicit bleeding. Following the application of the iodine solution a small grayish-white plaque, about 2 millimeters in diameter, was noted at the right lower angle. A biopsy specimen showed a slight thickening of the epithelial layer, with a small area sharply demarcated from the more normal appearing tissue and strongly suggestive of leucoplacia. One small nest of squamous cells, however, made us suspicious of malignancy, though various observers differed and some considered it benign. In view of the patient's history of postmenopausal bleeding, age, and the suggestive microscopical picture, a panhysterectomy was advised.

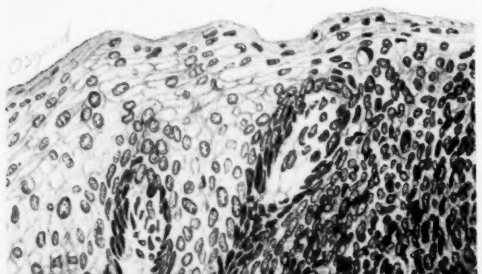

Fig. 15. Higher power drawing of *B* in Figure 14 showing more clearly the cellular differences between the two zones.

LAHM-SCHILLER TEST

It was noted by Lahm in 1927 that the portio vaginalis of the cervix displayed certain absorptive qualities following the application of Lugol's iodine solution. The chemical basis for this absorptive ability has been attributed to the presence of a glycogen-like substance in the cells of the spinal layer of the cervical epithelium. The clinical value of the test was further elaborated by Schiller, following a thorough study of different lesions and their reactions. However, the correct interpretation of the test is not a matter of simplicity, as there are many modifying factors present even in the normal cervix, and many that may serve to confuse the final picture.

In the crowded out-patient department the application of the iodine solution with a sponge is not only time consuming, but exceedingly inconvenient. To overcome this disadvantage we use a bulb atomizer; with the cervix well exposed and clean, it is relatively simple to spray the entire cervix under direct vision. The excess solution is removed with the speculum following the examination.

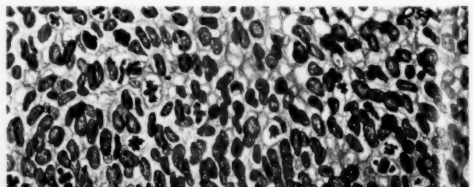

Fig. 16. High power drawing of *C* in Figure 14. Giant cells are also present, but are more numerous in the surface area. This is the earliest definite carcinoma of the cervix we have seen, and is of special interest in that it appears in an area of metaplasia commonly regarded as benign.

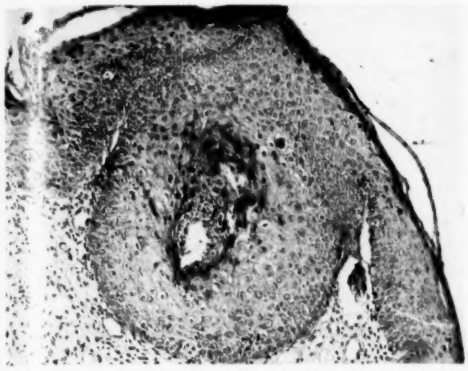

Fig. 17. An oval epidermal bud with marked karyokinetic asymmetrical division, peculiar clumping of the nuclei, and vacuolization of the cells. There is a moderate parakeratosis, with nuclei broken up into very small granules. A few large cells with numerous large nuclear fragments can be seen scattered through the entire epithelial surface. The picture is suggestive of those changes associated with arsenical keratoses and is not dissimilar to roentgen-ray dermatitis.

Previous digital examination with an oiled or soaped glove will tend to confuse the picture. When the cervix is covered with blood or discharge, spraying the cervix with a moderately strong solution of potassium permanganate and carefully wiping with a soft wet sponge is sufficient to ensure a clean surface. Care must be exercised in manipulation so as not to traumatize the cervical epithelium, thus removing the glycogen-containing cells and distorting the picture.

The normal surface of the pars vaginalis absorbs the iodine evenly and assumes a dark mahogany color. Nabothian follicles, as a rule, also absorb readily, but not infrequently stain to a lesser extent. In case of eversion with the columnar epithelium presenting, the stain is not absorbed by the everted mucosa and the color is a pinkish-red (Plate I, Fig. 6). This is disappointing, as the test is thus of no value in cases of adenocarcinoma. However, this type of growth is relatively infrequent, occurring only in 1 of 25 cases in our series.

The areas of erosion vary in relation to the intensity of the inflammatory reaction (Plate I, Fig. 5). The more acute the inflammatory process, the deeper the absorption, as the leucocytes, rich in glycogen, readily take up the iodine.

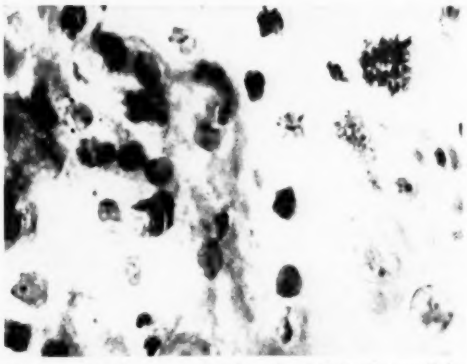

Fig. 18. High power showing the definite intracellular œdema and hyalinization; parakeratosis, hyperkeratosis, multinucleated giant cells with clumped nuclei, and a few pathological mitoses. There is no evidence of an invasive tendency and the cells are for the most part embryonal in character.

We have recently noticed certain variations in the pregnant cervix. In three young primigravidæ in the early months of pregnancy, and with cervices normal in appearance, the iodine was absorbed readily in two instances and taken up very lightly in the third. This was repeated a number of times with the same result each time. Biopsy failed to reveal any histological clue for this variability. We have also noted in apparently normal cervices following supravaginal hysterectomies that some of the cervices fail to absorb as readily as before the operation.

As a rule, the areas of metaplasia do absorb the iodine, as do cases of advanced malignancy, in which there is a marked secondary infection. With late cases having suspicious nodules in the vaginal vault, the application

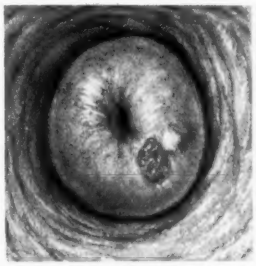

Fig. 19. Small grayish-white elevated plaque not unlike the preceding case in location and gross appearance. The pitted area is the site of the biopsy.

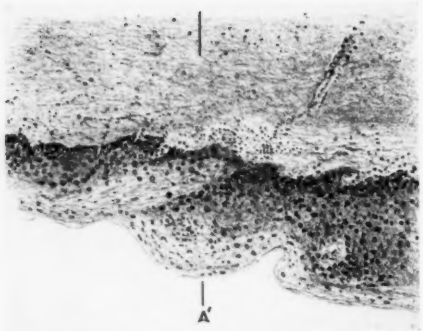

Fig. 20. The biopsy specimen showing an œdematous subepithelial layer with hyalinization, which is not uncommon in leucoplacia elsewhere in the body; also a scant round cell reaction. The transition between the obviously normal epithelium and the abnormal area is not as marked in this drawing as in Figure 22, but the transition in the stroma is surprisingly sharp, and extends through the entire area of the process.

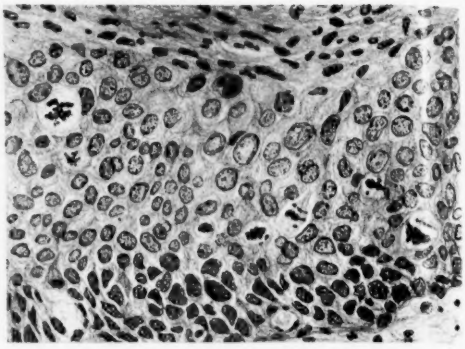

Fig. 21. High power drawing from the center of the process illustrating the peculiarly large giant-like cells with pathological appearing mitotic figures, the intracellular œdema and keratinization. This latter is more apparent in Figure 23. There are also a few abnormal mitoses. The intracellular œdema alone differentiates this process from extramammary Paget's disease, where intercellular œdema is present with the large characteristic Paget cells.

of the iodine may serve to outline the areas of malignant extension.

Leucoplacic areas are occasionally visible, without the aid of the iodine test, as small white or grayish-white plaques. But these vary from day to day in their gross appearance and whether this chameleon-like ability affects the absorptive power is not known. However, we have observed several cases in which the histological picture was that of typical leucoplacia, while the gross picture, even with the aid of the iodine, was negative.

Small areas of carcinoma of the squamous cell type present a picture identical with that of leucoplacia, so that the test is not specific for malignancy, but serves rather as an aid in selecting the site for biopsy.

Though this test is routinely applied to every patient in our dispensary and fully 25 per cent of the cases have been checked histologically, we do not at all feel that it is infallible. The use of the colposcope as advised by Hinselmann and others does magnify the gross picture, but with good exposure and

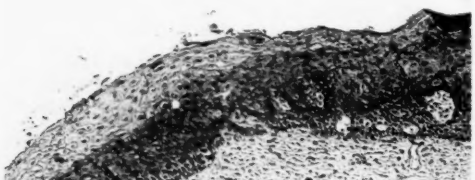

Fig. 22. Photomicrograph of the end of the lesion opposite that pictured in Figure 20. There is the characteristic oblique transition between the normal and the abnormal layers. The subepithelial œdema is apparent, but the hyalinization is not as clear. The large vacuolated multinucleated cells with the pale web-like cytoplasm is interpreted by some pathologists as belonging to the Paget cell group.

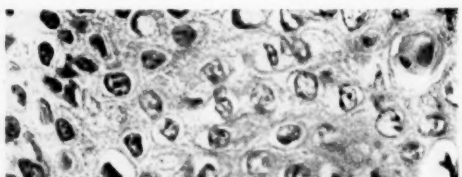

Fig. 23. Higher power to illustrate the intracellular œdema and keratinization, which is especially marked in this case.

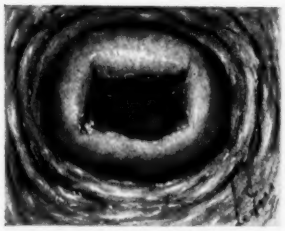

Fig. 24. Normal appearing senile cervix with typical erosion about the external os; the biopsy site at the lower right angle. On gross examination of the cervix after the removal of the specimen there was no suggestion of cancer.

light, the added cumbersome and expensive equipment is not indispensable. We have picked up several early cases of true carcinoma, which undoubtedly would have been missed without the aid of the test. An advantage of the test is the simplicity of its application especially with the aid of the atomizer. The test also necessitates a thorough study of the cervix with good exposure and light, a point in pelvic examination frequently overlooked. It is the only subsidiary diagnostic aid we have at present and warrants a thorough and fair trial.

BIOPSIES

In view of the admitted difficulties in the microscopical diagnosis of early carcinoma of the cervix, the amount of tissue for study must be sufficient to include not only the suspected area, but also some of the apparently normal tissue. For satisfactory interpretation of the histological picture an aggregate view of the changes must be obtained. Diagnosis based on the individual cellular changes is hazardous, especially when the tissue is scant in amount. One section from the area in doubt frequently misses the suspected process, while serial sections of the specimen will not uncommonly reveal the real nature of the lesion. We have been impressed with this on many occasions, and routinely follow this procedure.

The dangers of infection, dissemination or stimulation of the tumor growth, and hæmorrhages are apparently not as dangerous as they were once considered by many. In spite of any possible risks, the data obtained more than counterbalances them. That stimulation of

Fig. 25. Longitudinal section through the uterus, showing a definite well circumscribed intracervical carcinoma with the canal relatively free of the usual friable projections commonly present in malignancies of the cervix. Extending from the primary growth in the cervix is a thin layer of cancer of the squamous cell type which covers the entire endometrial surface, but does not extend out into the tubes.

the tumor growth occurs is a moot point; there is no proof that the growth is accelerated, and animal experiments show no change in the growth rate following trauma. Neither have we noted any infections following the biopsy, either with the punch forceps or with the scalpel. Three days after taking a biopsy from a normal cervix the wound is usually completely healed. In most cases the site of biopsy is touched with phenol or silver nitrate. Hæmorrhage, except in advanced cases, rarely occurs, and at most amounts to only a slight

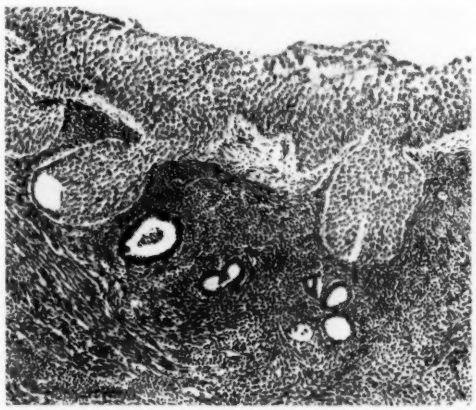

Fig. 26. Low power drawing showing the relation of the squamous cell cancer spreading like "cake frosting" (cancer of the "zuckerguss" type) over the entire endometrial surface; the endometrial glands are of the senile type. The growth has not invaded the myometrium.

venous ooze. An important factor in taking the biopsy is immediate fixation, for it has been shown that the alkaline secretions of the cervix bring about a definite fading of the nuclear particles and thus the resultant microscopical picture is hazy. Immediate freezing and staining is the ideal method, but when permanent serial sections are desired from a small bit of tissue, this procedure is difficult and undependable except in the hands of an expert.

The divergence of opinion as to the diagnosis in very early carcinoma of the cervix is disheartening, many still seem to cling to the older concepts of cellular confusion so characteristic of the late stages. At the other extreme are those who scent malignancy wherever there is a departure from the accepted normal of cellular activity. In order to appreciate fully the pathology of the cervix one must be especially equipped to diagnose the very early case. To attain this knowledge one must possess a familiarity with all the various cellular changes, checked by careful follow-up studies in each case. Merely to call the changes "suspicious" or "doubtfully malignant" is of little aid to the clinician, who wishes to be informed that the lesion is either benign or malignant. If the pathologist cannot decide either way, the responsibility reverts to the clinician, though when such doubt exists, the wise plan is often to defer active treatment until the question can be definitely settled, for such a slight delay will rarely endanger the patient.

SUMMARY AND CONCLUSIONS

The microscopic diagnosis of cervical cancer will not be improved until both the clinician and the pathologist learn more about such pseudomalignant and possible pro-malignant lesions of the cervix as have been discussed.

Mitotic figures are occasionally seen in the basal layer of the normal cervical epithelium and are to be looked upon as evidence of the normal growth and repair of the cervix.

Cervical lesions may be spoken of as "precancerous" when it is understood that the term implies they might though not necessarily become cancerous. The microscopical picture of these lesions is less perplexing if the mechanism of development is understood. That cancer does originate in the so called metaplasias is illustrated by 1 case.

Leucoplacia of the cervix is a pathological entity which may show cellular changes suggestive of cancer, though invasion is always lacking.

Two cases showing microscopical changes similar to both Bowen's disease and extramammary Paget's disease; a condition rarely, if ever, described in the cervix.

An interesting case is described of intracervical carcinoma, diagnosed with the aid of the Schiller test, and in which the malignant growth extended over the entire endometrial surface of the uterus.

The importance of biopsy is indisputable, but its value is increased if the specimen is immediately fixed and serial sections are made. Serial sections are of especial importance in cases of suspected early cancer.

The application of Lugol's solution with the atomizer simplifies the test. The Schiller test is undoubtedly of some value in the diagnosis of early cancer; whether it is a specific for the absence of the cancer is questionable.

To Dr. Thomas S. Cullen and Dr. Emil Novak we acknowledge with sincerest gratitude our indebtedness for the valuable assistance in the preparation of this paper. We also wish to express our gratitude to Mr. Milton Kougl for the splendid photomicrographs, to Mr. Leon Schlossberg for the colored plate, and to Mr. M. D. Deitrich and Mr. J. O. Osgood for the drawings.

BIBLIOGRAPHY

1. Bowen, J. T. Precancerous dermatoses: a study of two atypical cases of chronic atypical epithelial proliferation. J. Cutan. Dis., 1912, 30: 241.
2. Darier, J. La dermatose precancereuse de Bowen. Ann. de dermat. et Syphel., 1914, 1915, 5: 449.
3. Hinselmann, H. Zur Kenntnis der praecanceroesen Veraenderungen der Portio. Zentralbl. f. Gynaek., 1927, 51: 901.
4. Schiller, W. Early diagnosis of carcinoma of the cervix. Surg., Gynec. & Obst., 1933, 56: 210.

FULMINANT SINUS DISEASE

Study of the Pathogenesis[1]

FRANCIS L. LEDERER, M.D., F.A.C.S., Chicago, Illinois

THE nose with its accessory nasal sinuses is capable of giving rise to interesting and formidable pictures indicative of local and general disease. Acute osteomyelitis of the maxilla, especially in infants, occurs with sufficient frequency to lead to considerable theorizing as to its etiology and therapy. In studying the complicating factors and sequelæ of this condition we have tried to trace the ways by which it becomes associated with acute suppuration of the accessory sinuses of the nose.

The literature is replete with case reports of fulminant nasal sinus involvement; in these the various complications, the possible etiological factors, and the treatment applicable in each instance are discussed. The majority of reports name thrombophlebitis as the usual route of extension and stress conservatism in treatment. The autopsy material has been surprisingly meager, clinical evidence or biopsy specimens were usually taken as final. We were fortunately able to study, serially, sections made through the head of an infant 3 weeks of age, who, as the history indicates, developed a fulminating sinus infection manifested by external swellings about the face and associated with a concealed thrombus in the cavernous sinus. Even without the history, a careful study of the histological series would make it quite possible to trace in chronological order the entire course of the disease.

CLINICOPATHOLOGICAL FEATURES OF FULMINATING SINUS DISEASE

Fulminating sinus disease always has been considered a formidable condition because of the anatomical relationship between the sinuses and the surrounding structures. Endocranial, auricular, ocular, dental, and systemic involvement may result from extension of sinus infections. In speaking of a fulminating type of sinus infection, the writer refers to sinus disease which manifests itself by swellings about the face, osseous involvement, and intracranial signs and symptoms; other authors prefer to look upon this type as merely acute sinusitis. Yet the spread of infection by direct extension (continuity of structure), or through the lymphatics or the blood stream, and along the facial planes, foramina, and perineural sheaths, is well recognized; the pathological alterations which occur depend upon the special anatomy of the region.

The subject is of sufficient importance to note briefly the several possible pathways by which an infection in the sinuses of the nose may involve other structures. Since the particular type of sinus disease under consideration occurs so frequently in infants and young children, certain anatomical and developmental features demand special consideration. Aside from traumatic possibilities, infections may invade the cranium through congenital dehiscences — the ethmomaxillary suture or openings in the bony wall of the lamina papyracea or in the orbital wall of the maxilla. That infection can travel by way of the perineural sheaths requires some explanation. It is not generally known, apparently, that there is no direct connection between the lymphatic vessels of the peripheral parts and the intradural structures and that the sheaths surrounding the olfactory nerves, although they are continuous with the piarachnoid, do not contain lymph. Spread by lymphatics has heretofore been thought to be the common method of extension but the anatomical facts suggest otherwise (18).

Direct invasion of the vessel wall by way of communicating veins is probably the commonest mode of extension. The nose is particularly rich in venous drainage. The septic thrombus, proceeding by way of the diploic veins, may produce a retrograde infective thrombophlebitis or periphlebitis. Involvement of the cavernous sinus may occur through various venous routes, according to which areas of the nose and its surroundings are diseased. Foci in the anterior part of the

[1] From the Department of Laryngology, Rhinology and Otology, University of Illinois College of Medicine and the Research and Educational Hospitals; Francis L. Lederer ,Head of the Department.

Fig. 1. Characteristic external findings of œdema of the lids, one in an infant and the other in a 9 year old. Both responded to conservative therapy. These cases represent the experience usually encountered.

nose may extend to the sinus by way of the angular vein, whereas those in the interior of the nose and sinuses go through the ethmoidal veins. Such a case from my clinic was recently reported. In this instance a bilateral cavernous sinus thrombosis developed following a submucous resection of the nasal septum (7). Infected foci in the superior maxilla may spread by way of the pterygoid plexus. The anastomotic venous radicles also permit infection to be transmitted between these different channels. Caries and inflammatory erosion of bone (osteoclasis) may result from extreme pressure by inflammatory products or these products may cause a separation of the bone from its mucous membrane and mucoperiosteum.

Purulent inflammation of the nose, especially during influenza or any of the acute infectious fevers, may cause a reaction of the tissue which interferes with the normal ventilation of the sinuses. There may be anatomical obstructions, or there may be swollen turbinates impinging upon the septum even though the nose gives little evidence of inflammation, shows no bulging of the wall of the nasal cavity, and maintains a free flow of secretion. Usually it is the ethmoid sinuses that are involved, although a pansinusitis on the same side may occur. The ethmoid cells are well developed early in childhood and since acute upper respiratory tract infections are frequent, involvement of these sinuses is by no means rare. In addition, the vascular and lymphatic development is greater in children than in adults (3). The mucosa becomes œdematous and the underlying periosteum becomes infiltrated (periosteitis); the bone bleeds freely (osteitis) during operative intervention. The structures overlying or neighboring the bone may become swollen and the bone itself become sequestrated (caries).

CLINICAL PICTURE

A unilateral swelling of the upper lid is characteristic of frontal involvement (in children past the age of 5 years), a swollen lower lid is associated with ethmoid cell disease, or both lids may be swollen in a combined involvement (Fig. 1). The lids become infiltrated (periorbital and orbital cellulitis) and occasionally the infection may localize and form an abscess (orbital abscess—Fig. 2) or even break down to form a fistula (caries or necrosis—Fig. 3). Similar swellings, at first brawny and later soft, may occur over the frontal area and the cheek. Inflammation usually causes a thickening of the periosteum at the medial wall of the orbit, leading to a red, painful swelling near the inner canthus of the eye. There may also be pain localized to the involved area or referred to other parts of the head. The temperature may vary from 98 to 105 degrees F. Strangely enough, one may find a violent external manifestation in an individual who is not acutely ill. Figure 4 shows a rather striking picture of objective inflammatory reaction, without much sub-

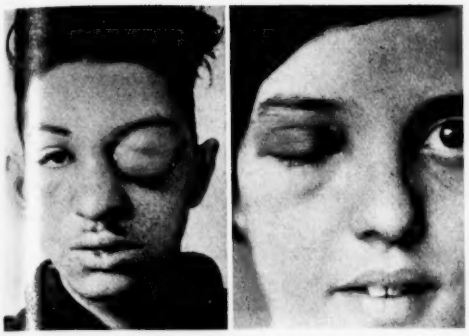

Fig. 2, left. An abscess of the lid which resulted from a periorbital cellulitis. This condition necessitated external drainage in addition to shrinkage and intranasal drainage.

Fig. 3. In this patient, as the result of a caries with abscess formation, a fistula from the floor of the frontal sinus occurred. An external approach, with the removal of sequestrated bone, when the acute process subsided, led to a resolution of the process.

Fig. 4. A striking picture is presented by such a marked objective reaction, as shown in this case, without much subjective response. In this patient the appearance was even more exaggerated because of the application of tincture of iodine to the forehead by the patient himself. The therapy in this instance, infraction of the middle turbinate and irrigation of the frontal sinus, favorably influenced the picture within 48 hours.

jective response. The eyeball itself may remain normal but occasionally becomes proptosed; the bulbar and palpebral conjunctivæ are decidedly chemotic. Motion of the eye may be limited owing to external rectus paresis or impaired motility of the extra-ocular muscles. When the proptosis becomes so great as to prevent the lids from covering the eye, corneal ulcers may form. A papillœdema may also occur in such cases. The predilection for the maxilla is explained on the basis of its larger size, more rigid construction, attachment to the skull—favoring a more frequent reception of trauma—and greater blood supply around areas of ossification. Unerupted teeth represent areas of greater vascularity, which may determine metastatic infection.

Saeger, reviewing 67 cases of orbital inflammations collected from the literature and one of his own, concluded that sinus disease is one of the most common causes of orbital inflammations in children. He quoted Coakley, Harke, Oppikofer, Wertheim, and Wolff, as showing by autopsies that the sinuses of children may be readily involved. Others believe that children do not have the essential predisposition for rhinogenic orbital inflammation that adults have. Theisen, in a study of 31 cases from his service in an infants' hospital, found the sinuses so commonly affected in orbital complications that confirmation by X-ray was not considered necessary. The orbital cellulitis is considered by Babbit as a secondary manifestation of infection—a syndrome rather than an entity. The cases with early external orbital manifestations are thought by Barwich to run a more benign course than those without external symptoms.

Approximately 75 per cent of orbital infections were secondary to disease of the nasal accessory sinuses, particularly the ethmoids, in a series of 60 cases reported by Porter. Eighty-two per cent of these were in children.

Fig. 5. Child, 3 weeks of age, showing a brawny swelling of the left side of the face. The eyelids are reddened, œdematous and almost closed. The œdema extended beyond the outer canthus to the temporal area and to the cheek where the induration was also brawny in character.

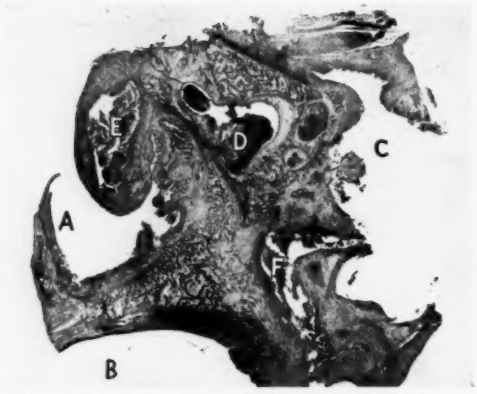

Fig. 6. Frontal plane section in the region of the deciduous molar and the respiratory portion of the nose. *A*, showing the breaking down of the mucosa below the inferior turbinate as though it had contained an abscess; *B*, roof of the mouth in the region of the hard palate and the area occupied by corpus adiposum buccæ (Bichat), *C*, between the masseter and external surface of the buccinator muscles. The antrum of Highmore, *D*, is filled with pus. The bony trabeculæ surrounding the antrum are seen to be in considerable confusion, not adhering to the regular arrangement of the normal lamellar structure. The inferior turbinate, *E*, contains a well walled off abscess cavity. The large fistula leading down into the mouth, *F*, is shown but in this section it appears to be connected merely with the abscess cavity in the cheek.

and of this number 7 per cent were directly due to abscessed teeth, 7 per cent to trauma, and the rest attributed to miscellaneous causes. There was a mortality of 5 per cent in this series, all of the deaths occurring among children under 2 years of age.

PATHOGENESIS

The relationship of osteomyelitis to diseases of the antrum invading the anterior portion of the cavernous sinus through the ophthalmic veins is discussed by Eagleton. He believes that when the infective process originates in the teeth, it may occasion an acute osteomyelitis of the superior maxilla, with involvement of the antrum; this rapidly perforates into the orbit and extends to the cavernous sinus. In these cases the infection travels, not by continuity of tissue suppuration, but by retrograde thrombosis, which later is the cause of the nutritional death (gangrene with sequestration) of the osseous parts. Ballenger (3) likewise believes that acute osteomyelitis of the superior maxilla may be secondary to buccal infection, the involvement following an infection of the dental sac. The inference in such cases is that the infection originated in the tooth, from which a retrograde thrombophlebitis ascended, causing not only nutritional death of tissue with consequent bony necrosis of antrum and ethmoids, but also orbital abscess, and finally involvement of the cavernous sinus.

An associated acute osteomyelitis is the result of the venous infection—not the cause of it. Drainage of the associated orbital abscesses cannot possibly control the disease, since the infection has already invaded the cavernous sinus itself. The literature shows how invariably futile drainage operations have been performed on the orbit, the ethmoids, and maxillary antrum—futile because such drainage does not attack the thrombophlebitis itself. If these cases were diagnosed early it is possible that operation upon the thrombophlebitic veins would offer a fair prospect of recovery.

The clinical pictures of osteomyelitis of the maxilla in nurslings and infants have been variously described and many factors have been named as causes. The disease may set in during the first week or up to the ninth month of the infant's life; the greatest incidence is during the first 3 weeks after birth. Pathological manifestations of redness, swelling, purulent discharge, necrosis and sequestration may be present on any or all of the surfaces of the maxilla (orbital, nasal, facial, and palatal).

Many cases of osteomyelitis of the jaw in infants are now on record and the subject has been extensively reviewed a number of times within recent years. It is unnecessary to consider in detail all of the various opinions that have been held for the pathogenesis of this disease. In early medical literature (12) cases of this type were presented as curiosities and were published as records of the early age at which empyema of the antrum may occur, rather than as contributions to the pathogenesis of the disease. In 1904 Kelly called attention to Schmiegelow's paper which had appeared 8 years before in which the clinical manifestations were attributed to an acute osteomyelitis of the maxilla. Kelly collected 17

Fig. 7. A vertical section in region of first permanent molar. The respiratory portion of the nose, *A*, with a break in the mucosa under the inferior turbinate indicating the rupture of an abscess. The palatal portion of the mouth indicates that a fistula has broken through the lower part of the maxillary sinus, *C*, and the tract, *E*, coursing downward, one part extending outward to a large abscess in the cheek, *D*, and the other progresses downward into the oral cavity, *B*. The facial wall of the sinus is completely destroyed and the presence of bone spicules is found. The zygomatic wall of the antrum as well as the root of the zygoma, *F*, has been destroyed.

Fig. 8. Frontal section through first permanent molar, *A*. The facial wall of the maxillary sinus is completely destroyed and a large fistulous tract containing spicules of bone, leading into the abscess in the fat pad of the cheek, *B*, and also finger-like projections reaching down into the tooth germ. (This photomicrograph is reversed but still concerns the same left side.)

cases, including his own, and concurred with the views of Schmiegelow. Since that time many theories have been advanced as to the cause of the osteomyelitis. The clinical pictures of all the cases on record are strikingly uniform, although the points of entry and method of spread of the invading organism are still matters of controversy. A résumé of the various views that have been held is presented in the recent papers of Bass and Wilensky. Few of the cases reported have been studied histologically, and it has been difficult to determine accurately the mechanism of the disease complex solely by clinical study. The patients are too often seen after the pathological condition is well established and as a consequence the primary seat of the process can only be inferred. Deduction by inference is the favorite method of clinicians in the reports which appear in the literature. We ourselves have never felt certain of the pathogenesis in the cases of ours that have recovered (11).

We have attempted to reconstruct pathogenetic processes from clinical and histological evidence obtained by preparing serial sections of the head of an infant who succumbed to an osteomyelitis of the maxilla (Fig. 16). It appears that many possibilities are present following a nasal infection. Dogmatic statements have been made by proponents of each mode of invasion to account for the osteomyelitic process. Swoboda and Zarfl favor the theory of inflammation of the toothbuds in the course of sepsis of the newborn. This hypothesis does not fit in with the clinical history or the pathology in the majority of the cases reported in the literature. In his most recent publication on the subject, Zarfl discusses the process as a necrotizing inflammation of the deciduous teeth. After an exhaustive histological study, he points out that the purulent inflammation does not begin in the tooth anlage itself but in the surrounding tissue and that involvement of the tooth anlage is secondary. On the basis of clinical and histological findings he divided his cases into two types: (1) phlegmonous and (2) osteomyelitic, according to whether the soft parts or the bone were primarily involved. He presents differences in the clinical course that correlate with the underlying pathological picture. The final cause of the disease is the entrance of organisms into the soft parts or bone marrow of the jaw. The infection spreads from an inflammatory focus in the region of the jaw or from a distant focus. The cases Zarfl grouped under the phlegmonous type had circumscribed foci (erysipelas

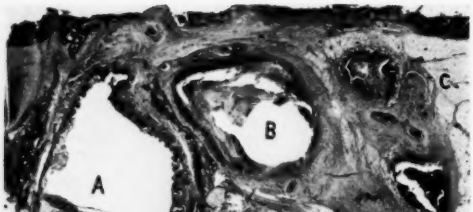

Fig. 9. Section through the posterior choana, *A*, showing the large abscess which has extended into the pterygoid fossa, *B*. There are two smaller abscesses in the region of the maxillary division of the fifth nerve, *C*, and a broken down area immediately below the lateral wall of the nasal cavity.

of the face and stomatitis), the infective process extending to the jaw by way of the lymph channels. In the osteomyelitic type there was a spread through the blood stream from a distant focus, such as would result from a furuncle.

According to Wilensky, osteomyelitis of the maxilla differs in no way from osteomyelitis in general. The localization in the jaws in nurslings is due to such traumatic factors as those incident to childbirth, cleansing of the mouth, etc. The position of the thrombophlebitis governs the site of the necrotic process. It is Wilensky's belief that the local clinical manifestations in the maxilla are determined by the dominating position of the thrombophlebitis in the vascular channels supplying the jaws.

From careful evaluation of the case reports and data on the subject of osteomyelitis of the maxilla in infants, it appears that the portal of entry and the method of spread of the primary infection may be variable. The fact that the entire tooth germ is sometimes exfoliated through the draining sinuses does not mean that the tooth anlagen were the original sites of the pathology or that they are especially liable to such involvement. It does not mean that the structures supporting them have been destroyed. In our case, despite the marked necrosis, the tooth pulps withstood the destruction remarkably well.

The phase brought out in the study of this case is that nasal infection and sinusitis must be considered as a possible primary cause in osteomyelitis of the maxilla in infants. It has been suggested through the clinical reports in the literature that such etiological factors are frequently present but the fact that the sinuses are incompletely developed in infancy has obscured their significance. The maxillary sinuses and ethmoidal cells are always sufficiently advanced in their development at birth to be of clinical importance and the microscopical studies in the present case makes their importance fully evident. It would seem, therefore, that nasal infection and sinusitis should receive more serious consideration when the pathogenesis of osteomyelitis of the maxilla in infants is studied.

REPORT OF CASE

Osteomyelitis of the maxilla in an infant following a purulent rhinitis producing an ascending and descending abscess formation and a cavernous sinus thrombosis.

R. B., a white male infant, 3 weeks of age, was admitted to the Research and Educational Hospital. The mother stated that 9 days prior to admission, the infant had a thick, yellow, nasal discharge. The infant was restless and refused to nurse. Fever was not present at this time. Two days later, the nasal discharge became thin and mucoid in character and coincident with this the left eye became reddened and a swelling appeared on the upper eyelid. In the next 24 hours the lower eyelid became swollen. Forty-eight hours later the child was taken to a doctor who found a point of swelling on the left upper gum margin. The next day there was a spontaneous discharge of thick bloody purulent material from the left nostril. This was followed by a progressive decrease in swelling about the eyelids. The day before admittance the infant developed several small fluctuant areas on the left cheek near the outer canthus of the left eye and the lids again became œdematous. Because of this the patient was brought to the hospital and admitted to the Pediatric Service. The mother believes that the infant has been without fever throughout the entire course of the illness. The patient was the second child of healthy parents. The mother had a normal, spontaneous delivery. The immediate neonatal history was normal and the patient did well until the time of the present illness.

Physical examination. The patient was a fairly well nourished infant. He did not appear acutely ill or toxic but was restless and irritable. No eruptions or lesions were present on the surface of the

body. Positive physical findings were confined to the head. The left side of the face was prominent. The left eyelid was reddened, œdematous and almost closed. The œdema of the eyelids extended beyond the outer canthus of the left eye almost to the temporal region. The left cheek and mandible were swollen and soft. The overlying skin had a faint purplish red color (Fig. 5). A scant amount of seropurulent material drained from the inner canthus of the left eye. The same type of discharge exuded from the left nostril and reappeared rapidly when wiped away. Pressure over the left maxilla increased the discharge from the left nostril. Upon rhinoscopic examination the material was seen to originate from below the inferior turbinate. The right nostril was clear. The left alveolar margin was swollen and boggy, and a fistulous opening was present in the region of the first molar tooth. A thick yellow discharge drained from this area and was increased in quantity by pressure over the left maxilla. The pharynx was diffusely hyperæmic throughout. The entire group of cervical lymph nodes on the left side was enlarged and firm to touch.

The urine was negative; examination of the blood showed: hæmoglobin, 68 per cent (Newcomer); red blood cells, 2,970,000; white blood cells, 13,650. The differential blood count revealed 49 per cent polymorphonuclears, 47 per cent lymphocytes, 3.5 per cent monocytes, and 0.5 per cent eosinophiles. Culture of the discharge from the left side of the nose, eye and the alveolar fistula revealed Staphylococcus aureus.

The child's temperature on entrance was 99 degrees F. but rose progressively in 4 days to 103 degrees F. Coincident with this rise there was an increase in the swelling and fluctuation of the areas described. A few fistulæ developed on the left side of the face just lateral to the outer canthus of the left eye. The cervical swelling increased, extending upwards to the zygoma. The patient failed to respond to supportive measures and died 6 days after entrance.

Postmortem examination. A terminal bronchopneumonia was revealed as the cause of death. A special histological study of the head was begun by Dr. Blayney of our Dental Department and collaborated in by Dr. Poncher and myself (13).

Microscopical report. The histological sections disclosed microscopical changes which were entirely in accordance with the clinical symptoms. The frontal section through the plane of the deciduous molar (Fig. 6) shows an old extensive osteomyelitic process of the inferior turbinal bone and also an involvement of the maxillary sinus which is much more recent. The lower border of the maxillary sinus presents a dehiscence from which a fistulous tract leads downward and then divides, one tract extending outward to a large abscess in the cheek and the other portion progressing downward into the oral cavity (Fig. 7).

A careful dental study of these histological preparations was made with particular reference to the soft tissues covering the tips of the enamel cusps and incisal edges of the deciduous teeth. Each dental anlage showed a sufficient pad of soft tissue between the oral epithelium and the tooth crown, precluding the possibility of any postnatal laceration or exposure of the tooth germ. It is quite evident that the involvement of the inferior turbinate is considerably older than that seen in the other regions of either the maxilla or mandible. These findings strongly suggest that the original infection was in the nasal cavity.

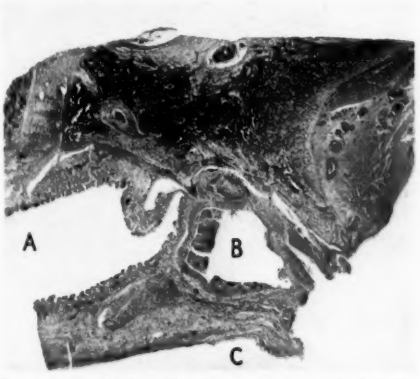

Fig. 10. Vertical section through the central region of the soft palate and the body of the lesser wing of the sphenoid. On the lateral wall of the epipharynx, *A*, is a cartilaginous projection which is the lamina medialis of the eustachian tube with the abscess encroaching upon it. The mandibular nerve is in close proximity to the abscess. The abscess, *B*, is located between the tensor and levator veli palatini muscles, from above, and the buccinator belly of the superior pharyngeal constrictor, below, *C*. In the destruction of the zygomatic root the process extended into the pterygomaxillary fossa.

The frontal section through the plane of the first permanent molar region, reveals that the facial wall of the sinus is completely destroyed. A large fistulous tract, containing spicules of exfoliated bone is seen to lead into the abscesses of the cheek; and a finger-like projection reaches downward, external to the tooth germ (Fig. 8). The zygomatic process of the antrum is seen to be destroyed with an extension of the phlegmonous process into the pterygomaxillary fossa. There are two smaller abscesses in the immediate vicinity of the maxillary division of the fifth nerve, and also one small abscess beneath the periosteum of the lateral wall of the nasal cavity (Fig. 9). Sections were studied through the various planes from this point posteriorly, such as the soft palate, the lesser wing of the sphenoid, the uvula, the body of the sphenoid and the sphenoidal fissure, and the greater wing of the sphenoid (Fig. 10). In the pterygoid fossa there is a small abscess and there are septic thrombi in a number of the adjacent veins. In a section anterior to the posterior wall of the pharynx, including the body of the

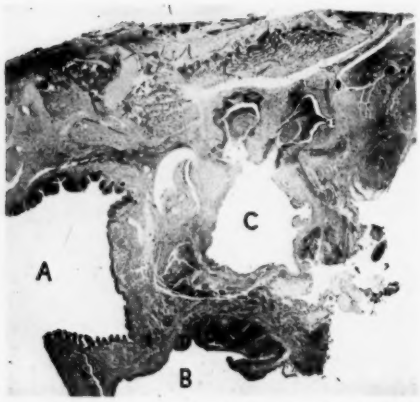

Fig. 11. Section at the level of the uvula, the body of the sphenoid, the sphenoidal fissure and the greater wing of the sphenoid. The posterior pharynx, *A*, and pharyngeal space including the tonsil, *B*, are normal but the abscess, *C*, in the muscle planes, shows much destruction of surrounding parts and septic thrombi in the nearby veins. The abscess is located in close proximity to the eustachian tube.

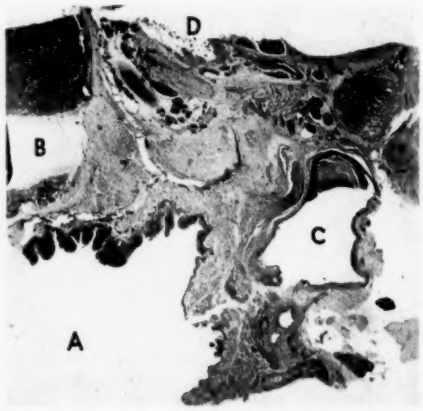

Fig. 12. Section in a plane just anterior to the distal wall of the pharynx, *A*, and including a portion of the greater wing of the sphenoid, the basilar process, *B*, and the abscess in the parapharyngeal area. The cavernous sinus area, *D*, including the internal carotid artery with the associated nerve trunks and ganglia (trigeminus [ophthalmic, superior and inferior maxillary (mandibular) branches], abducens, oculomotorius and trochlearis).

sphenoid and the basilar process, the cavernous sinus, the internal carotid artery with the associated nerve trunks and ganglia and a portion of the greater wing of the sphenoid are anatomically recognized (Fig. 12). There are several septic thrombi in the cavernous sinus (Figs. 13 and 14). The extension from the antrum through the maxilla was not limited to the distal direction but involved also the structure immediately above the deciduous central incisor and cuspid; the soft tissue between the oral cavity and the tooth crown was normal and unbroken (Fig. 15).

The study of the mandibular sections by Dr. Blayney disclosed an osteomyelitic process extending forward from the mandibular foramen to the region of the deciduous cuspid (Fig. 15, A). The degree of phlegmonous reaction and the amount of tissue destruction was much more pronounced in the maxilla than in the mandible. The mandible was separated from the maxilla at the time of autopsy, so that it is impossible to trace the direct extension of the aforementioned infectious process. However, in a section through the mandibular foramen, the abscess may be seen to enter the body of the mandible along with the mandibular nerve and vessels. Having seen that the zygomatic process of the maxillary bone had been destroyed and that the contents of the maxillary sinus had entered the pterygomaxillary fossa, it is readily understood in what manner the extension could take place along the planes of the buccal fascia, the pterygoid muscles, the sheaths of the third division of the fifth nerve and the inferior dental artery, thereby entering finally the lower jaw through the mandibular foramen (Fig. 10).

In a section through the first permanent molar region, a large abscess is found immediately beneath the dental pulp, in close proximity to the mandibular nerve (Fig. 15, B). Inferior to this, the major portion of the original mandibular bone is involved in an osteomyelitic process. The body of the mandible is completely surrounded by a formation of new bone, the trabeculæ of which are arranged at right angles to the surface. This arrangement of the trabeculæ is not present on the normal side and by its form suggests an effort on the part of nature to withstand the effects of internal pressure. Studies of the deciduous molar teeth reveal a large area of destruction, extension of this process along the lateral wall of the tooth, and complete disorganization of the enamel organ on the occlusal surface. The overlying soft tissue, despite these pathological alterations, is intact, thereby discounting any dental focus as a pathogenic factor.

Throughout the entire mandibular series, we are unable to find a trace of the inferior dental artery from a point posterior to the cuspid region. This fact seems to substantiate the statement that the infection entered the lower jaw by extension along the vessel sheath, ultimately destroying it, and that the involvement of the lower jaw was not the result of a thrombophlebitis. In the anterior region of the mandible the structures are found to be normal in appearance and arrangement.

Summary of the clinical and histological findings. The clinical course of the patient becomes coherent after close scrutiny of the serial sections of the entire head. There is incontestible evidence that the site of origin of the infection was in the inferior turbinate. Following a purulent rhinitis and sinusitis,

Fig. 13. High magnification through the internal carotid artery which is filled with septic thrombi.

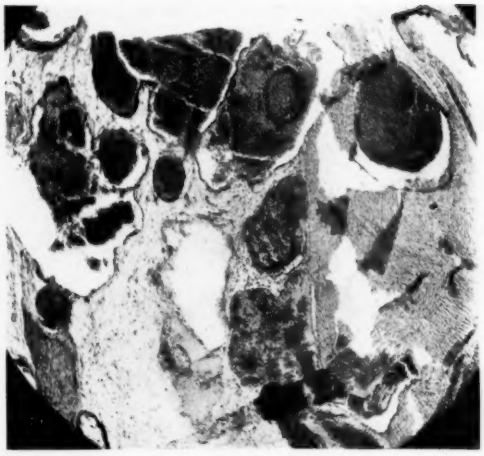

Fig. 14. Area of cavernous sinus showing veins thrombosed and containing septic thrombi.

the infant developed a periosteitis of the maxillary and ethmoid sinuses and periorbital cellulitis which later broke down (Fig. 5). From the suppurative process in the maxillary sinus and ethmoidal labyrinth septic thrombi invaded the venous channels producing a cavernous sinus thrombosis (Figs. 12, 13, 14). From the original site, the process extended to the maxillary sinus, producing a fulminating infection. The exudate in the maxillary sinus, by denuding the bone, caused a necrosis which gave rise to a fistulous tract at the floor of the sinus and broke through into the roof of the mouth (Figs. 6 and 7). The facial surface of the maxillary sinus was eroded by the carious process, thereby causing extension by continuity into the zygomatic arch and the soft tissues of the cheek (Figs. 7 and 8). The pterygoid fossa then became included in the extension from the zygoma (Figs. 9 and 10) and, by way of the fascial planes traveling along the pterygoid and buccinator muscles, the mandibular foramen became involved. The invasion of the foramen was by way of the nerve and vessel sheaths, and in the process one nerve was found to remain intact but the vessels were completely destroyed (Fig. 15). The parapharyngeal space contained a broken down abscess (Fig. 11).

The changes in the interior of the nose were most interesting. The osseous portion of the inferior turbinate was replaced by a necrotic mass. This is seen to be almost encysted, hence it would seem to be an older process (Fig. 6) than those which resulted from this infection. The epithelium of the turbinate is almost devoid of cilia although the mucosa is everywhere intact except in the inferior meatus where it has been destroyed (Fig. 7). This destruction in the inferior turbinate represented the oldest change; the fistula at the floor of the maxillary sinus and the organized thrombus in the cavernous sinus were next in sequence.

TREATMENT

Neither experience nor literature seem to solve the problem of therapy in these cases. Extremes of conservatism and radicalism are represented, with a fortunate tendency to the former. A typical experience is that of Ballenger (2), who had 8 spontaneous recoveries out of 11 cases, with no drainage other than that provided by the natural nasal orifices. Two of the cases drained by a spontaneous rupture through the orbit, one through the inner and another through the outer canthus of the eye. The 2 other cases required surgical interference, one an ethmoidal and the other an ethmoidal and orbital drainage. All of these cases recovered. Such an experience is not unusual.

Whether packs externally applied should be hot or cold is a matter of controversy, there being enthusiastic proponents for each form of therapy. Intranasal shrinkage and mild suction or irrigation are valuable. Procedures such as infraction of a turbinal, probing or irrigation of sinuses have not met with universal acceptance. The opinion often voiced is that these cases, representing as they do a fulminant type of pathological process, offer a

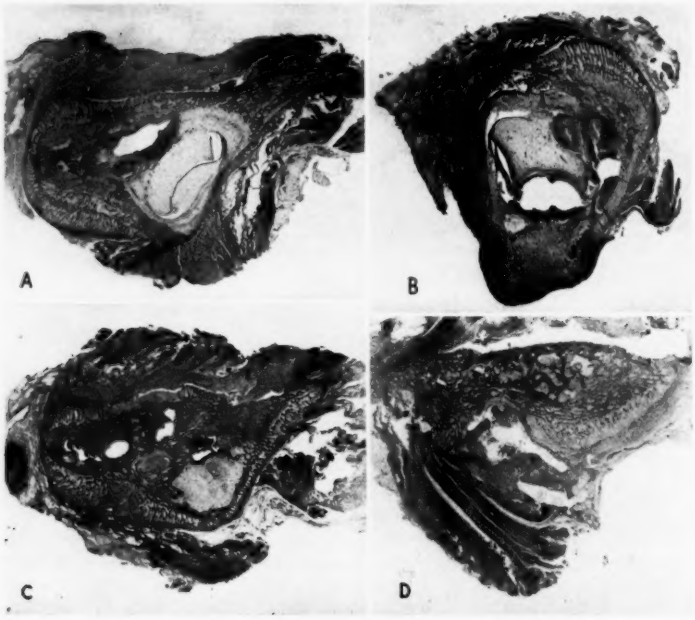

Fig. 15. A study of the mandibular series. A, Shows the area immediately above the deciduous central incisor and cuspid involved. However, the soft tissue between the oral cavity and tooth crowns is normal and unbroken. B, Section through the first permanent molar region. There is an abscess immediately beneath the dental pulp and in close proximity to the mandibular nerve. The major portion of the bone surrounding this area is involved in the osteomyelitic process. The body of the mandible is completely surrounded by new bone with trabeculæ arranged at right angles to the surface. C, The section through the mandibular foramen shows the abscess entering the body of the lower jaw along with the vessels and the nerve, which really constitutes the manner in which infection was carried to the mandible. D, The anterior region of the mandible shows a more active osteomyelitic process with sequestration and abscess formation.

better prognosis with a "hands off" policy. Those who have voiced this ultra-conservative attitude have probably experienced, in their own hands or those of their colleagues, unfortunate sequelae of sepsis, osteomyelitis, meningitis and dural sinus thrombosis. They lean, therefore, toward the opinion that any manipulation in the nose may bring on dire consequences, having no proof that the cases might not have gone on to such complications without these procedures.

In discussing the intranasal cases producing orbital symptoms and abscess, Faulkner advocates external evacuation of the abscess and exenteration of the ethmoids. Babbit comments on the similarity in the symptoms of orbital cellulitis and cavernous sinus thrombosis; he believes that the percentage of recoveries under radical procedures and the serious prognosis without interference justifies initial nasal sinus surgery, even in cases of doubt.

The treatment of orbital cellulitis and abscess varies with the severity of the symptoms according to Hawkins, who treats cases of "pure œdema" intranasally. He quotes Logan Turner who was able to cure 14 of his 18 cases in this manner. Children with ethmoid suppuration and exophthalmos responded to shrinkage, suction or irrigation in 24 to 48 hours, in Hawkins' cases. He further advises that adults may respond to simple irrigation, but, according to him, may require some type of operative procedure—intranasal, external,

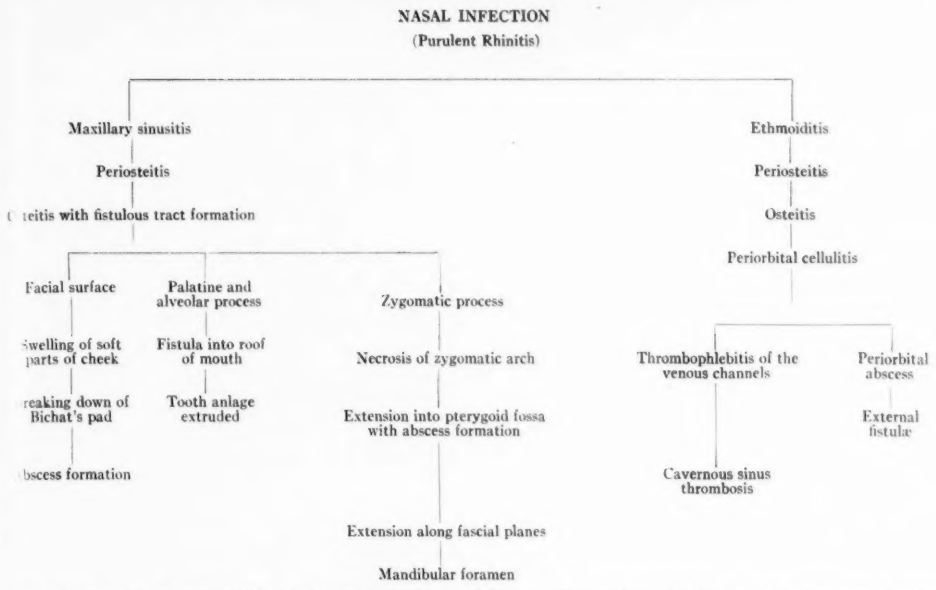

Fig. 16. Graphic representation of the method of spread from a primary focus in the nose to structures of the surrounding portions of the head. It is seen that this chronological representation follows very closely the comparative study of the historical sequence and the study of the histological series. Represented are possibly all the various routes by which a nasal infection may spread to the adjacent parts.

combined, or drainage of an orbital abscess. Whatever the type of operation, it should be sufficiently radical to insure adequate drainage, both of the infected sinus and the orbital pus. Such a radical attack should be carried out immediately when a cavernous sinus thrombosis manifests itself.

An expectant, conservative, attitude is adopted by Porter if there is a simple œdema of the lids (which he terms the first stage). This consists of shrinking the nasal mucosa, warm saline irrigations and cold compresses externally. If after 24 to 48 hours there is no improvement, or if the condition has progressed, he advocates, for children who have cloudy ethmoids and antra, a removal of the anterior ends of the middle turbinate opening into the ethmoid labyrinth, and frequently uses intranasal antrotomy. In the adult the radical antrum operation is performed instead of the intranasal. If there is œdema of the lids and exophthalmos with limitation of motion (he terms this the second stage), an even more immediate and radical intervention is advised, consisting of an external ethmoid exenteration, and possibly removal of the floor of the frontal sinus and a sublabial approach to the antrum, if it is involved.

On the basis of clinical reports, it is difficult to arrive at an adequate evaluation of the therapy in these fulminant sinus infections. We can say definitely that conservative measures will suffice in the majority of cases, where the bacterial invasion is not virulent and its nidus is within natural cavities that may be readily drained. Such foci may be drained by shrinkage medication, suction or irrigation. With areas that are not so accessible a surgical approach becomes necessary. As Porter has shown, surgery is obviously indicated when the process is not responding to the expectant treatment and drainage is not established. Intranasal surgery has always been shunned in the presence of an acute infection and statistics seem to indicate that surgical intervention in fulminant sinus infections is attended by an appalling morbidity and mortality. Such statistics are logical only if we know at what stage of the infection drainage was attempted and the character of the procedure

(especially the incident trauma). External procedures rather than intranasal operations have been advised because of a possible spread to the meninges. We feel that here again we should choose the route nearest to the area which we desired to drain and—more important still—should as far as possible avoid operative trauma. We have frequently found it best to advise procedures in accordance with the ability of the surgeon.

CONCLUSIONS

An interesting histological survey, directed toward study of the pathogenesis of osteomyelitis of the maxilla in an infant, and of the means of extension and complication reveals a great number of diverse basic factors in cases clinically similar to each other. It is evident from a study of the literature that the portal of entry and method of extension may be variable. Dogmatic statements have been made by proponents of each mode of invasion but a careful study of our case has shown that the various modes of extension may all be involved in such processes. Evidence is presented to show conclusively that nasal infection and sinusitis may play an important rôle in the pathogenesis of such a process, even in early life.

Very few of the cases recorded in the literature have had serial histological studies, and because it is difficult to determine the disease complex solely by clinical means, dogmatic and erroneous conclusions have been forced upon the rhinologist. The patients are often first seen after some time has elapsed so that the primary process is declared by inference only. The present study offers a logical explanation of many earlier unexplained cases.

We advise an expectant conservative attitude in the early stages of the disease, when œdema of the lids is present. If the process does not show a tendency to regress and if symptoms become more marked, surgical interference must be contemplated.

The surgical approach can be intranasal or extranasal, the route determined depending upon the proximity to the focus to be drained and the chances of avoiding trauma. The choice of procedure depends chiefly upon the technical skill of the surgeon.

In the case reported probably no therapy, conservative or radical, could have halted the extensions of the bacterial invader or saved the life of the patient. Past experiences would indicate that palliative medication has its distinct merits in the treatment of the majority of cases. Radical interference undertaken at the proper time should give a good prognosis. Of the operative procedures surgery for drainage appears most advantageous.

BIBLIOGRAPHY

1. Babbit, J. A. The diagnostic problem of orbital cellulitis. Ann. Otol., Rhinol. & Laryngol., 1930, 39: 444-457.
2. Ballenger, H. C. Orbital cellulitis and abscess secondary to sinusitis. Illinois M. J., 1932, 61: 128-131.
3. Ballenger, W. L. Diseases of the Nose, Throat and Ear. 6th ed., p. 548. New York: Lea & Febiger, 1930.
4. Barwich, M. Disease of accessory nasal sinuses in scarlet fever. Wien. med. Wchnschr., Nov. 28 and Dec. 5, 1931.
5. Bass, M. H. Am. J. Dis. Child., 1928, 35: 65.
6. Eagleton, W. P. Cavernous Sinus Thrombosis. New York: Macmillan, 1926.
7. Fabricant, N. D. Cavernous sinus thrombosis following submucous resection. Arch. Otol., 1933, 17:634–639.
8. Faulkner, E. R. Rhinological aspects of cavernous sinus thrombosis. Surg., Gynec. & Obst., 1931, 52: 474-478.
9. Hawkins, R. W. Relation of exophthalmos to nasal sinus disease. New York State M. J., 1933, 33: 65-68.
10. Kelly, B. Edinburgh M. J., 1904, 16: 302.
11. Lederer, F. L. Pathogenesis and end-results of dural sinus thrombosis. Arch. Otolaryn., 1934, 19: 410.
12. Mayer, E. New York: Med. Rec., 1901, 60: 210.
13. Poncher, H. G., and Blayney, J. R. Am. J. Dis. Child., 1934, 48: 730-738.
14. Porter, C. T. Etiology and treatment of orbital infection. Ann. Otol., Rhinol. & Laryngol., 1932, 41: 1136-1141.
15. Saeger, F. Concerning orbital inflammations in early childhood. Monatsb. f. Augenh., 1927, 78: 650–663.
16. Swoboda, N. Verhandl. d. Versamml. d. Gesellsch. f. Kinderh. Breslau, 1904, Therap. d. Gegenw., Berl., 1904, 14: 515.
17. Theisen, C. F. Ethmoiditis in infants and young children with accompanying eye and orbital complications. Tr. Am. Laryngol. Ass. (50th annual meeting, Washington, D. C., May 1–3, 1928.) 1928, 163: 182.
18. Turner, A. L., and Reynolds, F. E. Intracranial Pyogenic Diseases. Edinburgh: Oliver and Boyd, 1931.
19. Wilensky, A. O. Am. J. Dis. Child., 1932, 43: 41; Arch. Surg.; 1932, 25: 183.
20. Zarfl, M. Ztschr. f. Kinderh., 1920, 25: 266.

NORMAL HUMAN OVUM IN THE PRIMITIVE STREAK STAGE (APPROXIMATELY EIGHTEEN AND ONE-HALF DAYS)[1]

HAROLD O. JONES, M.D., F.A.C.S., AND JOHN I. BREWER, M.D., CHICAGO, ILLINOIS

COMPARATIVELY few young human ova, normal and anatomically complete, have been described. The ovum[2] to be reported here seems to fulfill these requirements. In addition, an exact sex history has been obtained from the husband and wife as follows:

February 16, 1932, menstruation began.
February 22, 1932, menstruation ended.
February 26, 1932, coitus.
February 28, 1932, coitus.
March 4, 1932, coitus (evening).
March 10, 1932, entered hospital.
March 13, 1932, menstruation expected but failed to occur.
March 24, 1932, hysterectomy (morning).

The body of the uterus as removed measures 10.5 by 7.5 by 4.5 centimeters and has no pathological changes. The wall is 3 centimeters thick, 1 centimeter being endometrium. The cavum has no blood. On the posterior wall of the endometrium there is a slightly depressed hæmorrhagic tissue 1 millimeter in diameter. Centered 1 millimeter directly beneath this is the blastocyst. The external measurements of the unfixed chorionic vesicle are 8 by 7 by 4 millimeters. The internal measurements (chorionic cavity) are 6 by 5 by 2.5 millimeters. The yolk sac is 1 millimeter in diameter before fixation. The amniotic cavity measured in the section is 0.66 by 0.816 by 0.20 millimeters in its greatest dimensions. The caliper measurements of the embryonic disc made on the model at 200 diameters are 115.9 millimeters long by 147.5 millimeters wide. The primitive groove similarly measured is 40.9 millimeters long. The length of the primitive streak including Hensen's node is 87.5 millimeters. Reduced to actual size the length of the disc is 0.58 millimeters, the width 0.74 millimeters, primitive groove 0.205 millimeters, and the primitive streak including Hensen's node 0.438 millimeters.

These facts and those to follow support the conclusion that this ovum is normal and complete. The normal uterus was removed for the purpose of sterilization. The imbedded ovum was implanted at the usual site on the posterior wall of the uterus. The size and stage of development of the ovum were consistent with the menstrual and coital histories. Invasion of the maternal tissue by fetal elements was in active progress. The fundamental relationships of the embryonic plate, yolk sac, amnion, chorion, villi, and endometrium were normal and agreed with those described by Bryce-Teacher, Frassi, Eternod, and others which are accepted generally as normal. The cells of the embryonic plate were in active mitotic division. The Langhans' cells and the cytotrophoblast were multiplying rapidly by mitotic division. There was no cellular degeneration of the villi. Anchoring villi were few and were loosely attached.

The ovum and the embryonic anlage were anatomically complete and were sectioned and arranged serially. The entire unfixed blastocyst tissue together with a small amount of the surrounding endometrium was divided into four portions and placed in fixing solutions within 10 minutes after the maternal blood supply had been clamped. The block of tissue containing the embryonic anlage was fixed in formalin-Zenker's solution, and the 3 others were placed respectively in Regaud's solution, 10 per cent neutral formalin, and formol-Zenker's solution with subsequent osmic acid fixation. All the tissues were imbedded in paraffin. The block containing the embryonic structures was cut serially at 10 microns, and the sections were stained with hæmatoxylin and eosin. All other blocks were cut serially at 5 to 6 microns.

The stains used were acid fuchsin-methyl green, acid fuchsin-Mallory III, phosphotungstic acid-hæmatoxylin, osmic acid counterstained with methyl green, copper chrome hæmatoxylin, iron alum hæmatoxylin, scarlet

[2] A comprehensive description of the embryo will be published later.

[1] From the Gynecological Service and the Henry Baird Favill Laboratory of St. Luke's Hospital and the Department of Anatomy of the University of Chicago. Aided by a grant from the Rockefeller Foundation to the University of Chicago.

red, Best's carmine, Bielschowsky silver technique, Mayer's muchematein, Bismark brown, and hæmatoxylin and eosin.

ESTIMATION OF AGE

The coital history presents crucial evidence for determining the age of our ovum. Recent evidence indicates that ovulation usually occurs near the middle of the menstrual cycle (Allen, et al). Accordingly, the last ovulation in our patient occurred about March 3, 1932. The viability of injected spermatozoa in the human is variously stated to be from 1 to 3 days. Thus, the coital relations that occurred on February 26 and 28 are too far separated from the calculated date of ovulation to be significant. The isolated and last coitus on March 4, 19½ days before operation, coincides closely with the estimated date of ovulation. On this basis the maximum copulation age is 19½ days. The minimum copulation age is 14 days, since the patient was in the hospital 14 days prior to operation. Mall states that the copulation age is 24 hours longer than the actual or fertilization age. Deducting 1 day from the computed ovulation age, the fertilization age of our ovum is 18½ days.

The calculated age is substantiated by comparison with other young human ova. The Grosser (Kl_{13}), Ingalls, Heuser, Frassi, and Eternod (Vuill) specimens (about 19 days) have larger measurements, the external diameter of the chorion being 10 millimeters. The Grosser and Ingalls ova have head processes, chordal canals, cloacal membranes, and beginning medullary folds. The Frassi and Eternod ova contain, in addition, neurenteric canals, medullary grooves, and blood vessel formations in the body of the embryos.

The ova described by Miller, Bryce-Teacher I, Peters, Jung, Merttens, and Strahl-Beneke have internal chorionic measurements ranging from 0.44 millimeters to 3.8 by 2.2 by 1.2 millimeters. The measurements of the embryonic shields, while not absolutely trustworthy, vary up to 0.75 by 0.3 millimeters. The well known Miller and Bryce-Teacher I ova have no definitive villi, while one described by Peters has beginning villi formations. In the Jung specimen the villi evidence some branching. In the Strahl-Beneke ovum, a primitive streak is present. The ages of these ova are stated by Streeter to be from 11 to 15 days and by Grosser from 12 to 18 days. (The Miller ovum is not listed in Grosser's classification: Grosser 1927.) Falkiner recently described a human ovum associated with a good clinical history and estimated its age at 15 days. The villi are beginning to branch and the yolk sac is larger than the amnion.

Closely approximating the description of our ovum is that of the Mateer ovum the age of which is placed by Streeter at 17 days. The measurements of the Mateer ovum, however, are slightly greater. The blood vessels of the villi contained primitive blood cells, while in our specimen the vessels are empty.

Kindred, in reporting the Goodwin ovum, calculates the age to be about 19 days. Although the given measurements are smaller than those for our ovum, the presence of the described head process indicates it to be more mature.

Our ovum with its primitive groove, allantois, blood vessel formations in the wall of the yolk sac, in the body stalk, in the chorionic membrane, and in the villi, with a yolk sac larger than the amnion, and with branching villi, falls into Group II of Streeter's classification. The internal measurements of the chorion are also within the limits given by Streeter for this Group. Since our ovum contains the earliest stage in the formation of a neurenteric canal that has been described for the human, it is placed in the borderline between Groups II and III (Streeter). It is definitely less advanced than the ova of Group III (Grosser-Kl_{13}), Ingalls, Heuser, Frassi, and Eternod Vuill.

The more exact estimation of its age (18½ days), the immediate and excellent fixation, the favorable plane of section, and the completeness of the specimen make possible a precise classification of this ovum in the series of human ova.

THE VILLI

The villi vary in size and shape and cover the entire surface of the blastocyst (Fig.). The longest is 0.1 millimeters. Many are branched once and a few twice. Each has a central mesodermal core and a covering of

syncytium and Langhans' cells. The Langhans' cells are small, cuboidal, or oval, with scant granular cytoplasm, large clear nuclei, and one or two nucleoli (Fig. 2). Each cell has a definite membrane. Many are in mitotic division. Glycogen can be stained in these cells. The vacuolization of the cells as demonstrated by Falkiner was not present. The syncytium is a finely granular protoplasmic film with nuclei distributed through it. It is spread irregularly over the surface of the Langhans' cells and stained deeply. The nuclei have a single nucleolus. Glycogen could not be demonstrated in this syncytium. Mitochondria stain as thin threads. In many places there is a brush border. The syncytium does not in this specimen completely surround and wall off the implantation cavity, the picture differing in this respect from that described by other writers.

VASCULAR ANLAGE

There are blood vessels in various stages of development in the villi, chorion, body stalk, and in portions of the wall of the yolk sac. In the villi, chorion, and body stalk the development is similar, while in the yolk sac the formations differ and are considerably more advanced.

All the larger villi contain angioblastic strands or short tubes, while many of the smaller villi do not. In the absence of specific study and plotting, there is no manifest difference in the number or degree of development of vessel formations in the villi, chorion, and body stalk. All stages from fine mesodermal strands to fully formed short endothelial tubes are present. The strands usually located near the center of the villi consist of groups of mesodermal cells with indistinguishable cell membranes. They are short and, in serial sections, have no connections with other neighboring strands or vessels. Some contain vacuoles in the central portion. Because the cell boundaries could not be discerned, it cannot be stated whether the vacuoles are intracellular or extracellular. By confluence and enlargement of the vacuoles, a lumen is formed, surrounded by a ring of cytoplasm and flattened nuclei. These formations likewise are isolated. A few of the formations are branched.

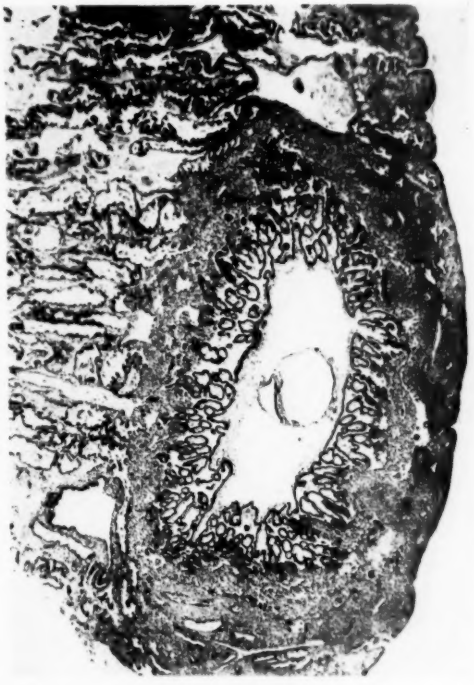

Fig. 1. Photomicrograph of a slightly oblique section of blastocyst embedded in endometrium. Section 15–2. ×12.

Since the vessel primordia are distributed evenly through the villi, chorion, and body stalk; since the individual strands and vessels are independent of connections or communications with neighboring strands; and since the formations are equally well differentiated over the entire chorion, they probably arise *in situ*. There are no cells in the lumen of the endothelial tubes in the villi, such as Streeter described for the Mateer ovum and called future blood cells. In the body stalk there is similar differentiation of mesoblastic cells into strands—some solid, some with vacuoles, and some with a lumen. There is no evidence that these as yet join with the strands of the chorionic membrane. In a place at the edge of the body stalk is a single blood island formation similar to those observed in the wall of the yolk sac.

In the wall of the yolk sac, the blood vessel formations are restricted to the caudoventral

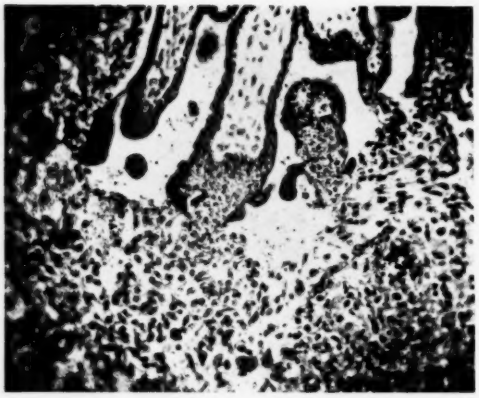

Fig. 2. Photomicrograph of a villus and cell column. ×35.

portion, and have developed further than those in the villi. Here the endothelium and the primitive blood cells differentiate simultaneously from blood islands. The origin of the blood islands is undoubtedly in the mesoderm. Throughout the vascular region, the mesoderm and entoderm are closely approximated, but at all points in this ovum, a definite separation of the two is discernible. Vessel formations occur in the mesodermal covering of the yolk sac. There are many small diverticula and areas of thickening of the entoderm in the vascular area; but in serial sections they are independent of blood vessel and blood cell formation (Fig. 3). The vessel, *c*, shown in this figure in serial sections curves around the diverticulum of entoderm. Early blood islands consist of a few mesoblastic cells. These increase in number, become larger, and contain vacuoles. Around the border of the island, are a few differentiated cells with flattened nuclei resembling those of endothelium. The inner cells become separated from one another, and lie in the space enclosed by the endothelial-like cells. In Figure 3 a closed endothelial tube, *c*, is illustrated containing in its lumen two types of cells, presumably primitive blood cells. The smaller cells are 0.008 millimeters in diameter with deeply stained granular cytoplasm and large, darkly stained nuclei containing one or two nucleoli. The larger, 0.013 millimeters in diameter, have a paler staining, a finely granular cytoplasm and pale nuclei. Some of these cells are in mitotic division.

In the absence of adequate staining procedures, no statement can be made concerning the hæmoglobin content in these cells.

CYTOTROPHOBLAST

The cytotrophoblast is considered to be of fetal origin, and its intimate association with the Langhans' cells of the villi has been repeatedly noted. The evidence obtained in this study and also in the investigations of the trophoderm in tubal pregnancies upholds this view. The Langhans' cells extend beyond the ends of the villi whose tips are not invested with syncytium, and spread in all directions (Fig. 2). Similar masses from adjacent villi join to form a sheet of cells overlying the decidua. To these cells the term cytotrophoblast is given, and a careful study shows them to be identical with the Langhans' cells. In Figure 2 the cells in a cell column near a villus are shown to be comparable to the Langhans' cells within that villus. Both are small, cuboidal, and have scant granular cytoplasm and large nuclei. In both, also, glycogen is present. The similarity of the two cell types is shown conclusively in the changes that occur in the formation of syncytium which are to be described later. That these cells have their origin in the Langhans' cells located near the tips of the villi is evidenced by the marked frequency of cells in mitosis at these points, and by the diminution in number and complete absence of mitotic figures nearer the decidua. Miller reports active mitotic division of the cytotrophoblastic cells; and Bryce-Teacher likewise report a similar division, but to a lesser extent, in their ovum II. The growth of the cells outward from the villi is further indicated by the retrogressive changes. Near the villi only a few cells are degenerating, while numerous cells more remote from the villi have undergone complete regression. The more distant cells contain lipoid droplets stained with both scarlet red and osmic acid. The droplets are small and are distributed evenly through the cytoplasm. These cells are larger; the membranes are irregular; the nuclei are pycnotic; and the cytoplasm is scant and poorly stained.

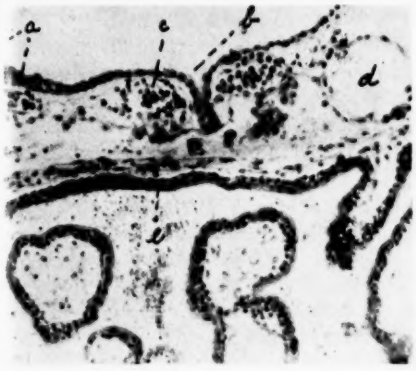

Fig. 3. Photomicrograph of blood vessel formations in caudoventral portion of yolk sac. *a*, Entoderm; *b*, diverticulum of entoderm; *c*, endothelial tubes containing primitive blood cells; *d*, mesodermal cyst; *e*, chorionic membrane. ×115.

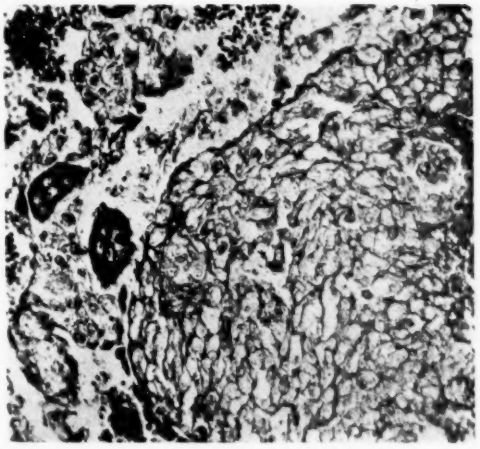

Fig. 4. Photomicrograph of a section through the penetration zone. Bielschowsky's silver technique. ×145.

These facts and the definite observation of formation of syncytium from the cytotrophoblast, indicate that the cytotrophoblast consists of fetal cells. In support of this conclusion is the absence of connective tissue among these cells. In no portion of the ovum is there maternal connective tissue. Silver and Mallory connective tissue stains contrast sharply the fetal and maternal elements. In Figure 4 a section stained with the silver technique is shown. The connective tissue ends abruptly at the decidual edge; and between the fetal and maternal cells there is a narrow layer of fibrinoid. In the cytotrophoblast no connective tissue is stained. In seriated sections there is no doubt of the definite, abrupt separation of these two tissues. At places where the separation by fibrinoid is distinct, degeneration of the decidua is at a minimum and penetration by fetal cells is infrequent. In places where penetration is more active and degenerating decidua cells are more abundant, there is a less clear separation. In places, strands of maternal connective tissue jut out beyond the degenerating decidual cells.

Other recognizable remnants of endometrial stroma cells also indicate the boundary of the maternal tissue. These stroma cells are small, flattened and elongated, and have large cytoplasmic granules in the curve of the vesicular, kidney-shaped nuclei. The granules are not dissolved by lipoid solvents, and are stained red with acid fuchsin and black with hæmatoxylin in sections fixed in Regaud's solution and in formol-Zenker's solution with osmic acid fixation. In this specimen, these cells are found only in the endometrial stroma through which they are distributed evenly in great numbers. In the degenerating regions the large cytoplasmic granules remain distinct even after the cell has degenerated almost completely. These structures indicate the boundary of the maternal tissue.

In sections of the ovum stained with Best's carmine for glycogen a differentiation of fetal and maternal tissue equally as sharp as that demonstrated by connective tissue stains is observed. The cells of the cytotrophoblast and the Langhans' cells contain glycogen in small amounts. The granules are small and unevenly distributed through the cells. Grosser also reports the presence of glycogen in the cytotrophoblast. Happe states that glycogen is found in the connective tissue of the chorionic plate and larger villi, but in our material none is stained in these cells. The young decidual cells of the implantation site and the vera have no glycogen. The glycogen may be absent in these cells because the tissues were fixed in formol-Zenker's solution and not in alcohol. Since stainable glycogen is present in cytotrophoblast and fetal wandering cells, it seems probable that glycogen in decidual cells is more labile and has been dissolved.

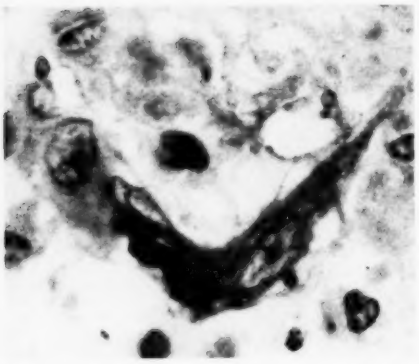

Fig. 5. Photomicrograph of a fetal wandering cell in contact with a decidual cell at the left. Stained with Best's carmine to show glycogen. ×975.

Glycogen is present in large cells scattered through the decidua at the sides and base of the blastocyst (Fig. 5). Beneke, P. Meyer, Bryce-Teacher, Peters, Strahl, and Falkiner describe these large cells, but make no statement concerning their glycogen content, which in our material distinguishes them from maternal cells. Beneke, Meyer, Strahl, and Falkiner believe these cells to be of fetal origin, while Bryce-Teacher suggest that they are maternal cells. Peters states he is uncertain of their origin.

Two types of fetal wandering cells are evident. In our specimen, their origin can be traced definitely to the cytotrophoblast. Cells in the cell columns at the tips of the villi identical with Langhans' cells increase in size; the cytoplasm concentrates about the nuclei; and the acid stain is taken with avidity. The cells increase in size, the cytoplasm becomes more dense, and the nuclei have one or more clefts and a single large nucleolus. The cytoplasm becomes still more dense and granular, remains concentrated about the nuclei, and stains more intensely with acid dyes. In the cytoplasm mitochondria now appear stained as long thin threads and filaments. Figure 6 illustrates such a cell among its neighbors and separated from the decidua by a venous space. The mitochondria are similar in sections fixed in Regaud's solution and in formal-Zenker's with subsequent osmic acid fixation for two days. In Figure 7 a wandering cell of one type is shown in the decidua adjacent to a vessel. By comparison to a decidual cell, the fetal cell is larger. It contains glycogen in this preparation, and the decidual cells do not. It has mitochondria, whereas the decidual cells do not. The nuclei of the decidual cells are even, rounded or oval with 1, 2, or 3 small nucleoli in contrast with the cleft nuclei and single large nucleoli of the fetal wandering cells. The other type of fetal wandering cell is illustrated by Figure 5. These cells stain darkly and invade the decidua in streamer-like formations, one cell behind the other. Their shape varies during invasion. Many are elongated and tenuous as in Figure 5. Others located in maternal capillaries are spherical. Many contain glycogen; and in some, mitochondria stain as threads and short rods. Some have several nuclei.

SYNCYTIUM

The theory that syncytium originates from the cytotrophoblast is upheld by Peters, Streeter, Jung, Miller, and others. The theory that it originates from maternal endothelial cells has been so convincingly disproved that it can safely be disregarded. In the ovum reported here, the formation of the syncytium is followed from the cytotrophoblast in more detail than has previously been done.

The syncytium develops similarly to the fetal wandering cells as noted above, up to the appearance of mitochondria. From here on, a variation occurs. After the formation of the large cytotrophoblastic cells with dense cytoplasm and mitochondria, two or more of the cells fuse to form a multinucleated mass, or such a single cell is surrounded and taken up by an already formed syncytial mass. The staining reaction of the syncytium is similar to that of the large cytotrophoblastic cells. Mitochondria remain as thin threads in the syncytium (Fig. 8). Identical changes with the subsequent formation of syncytium take place in the Langhans' cells within the confines of the villi. Since syncytium develops from the Langhans' and the cytotrophoblastic cells in a similar manner, it is evident that these latter two cell types are fundamentally similar and have a common origin. Many of the syncytial masses have brush borders (Fig. 9). Brush borders or pricle

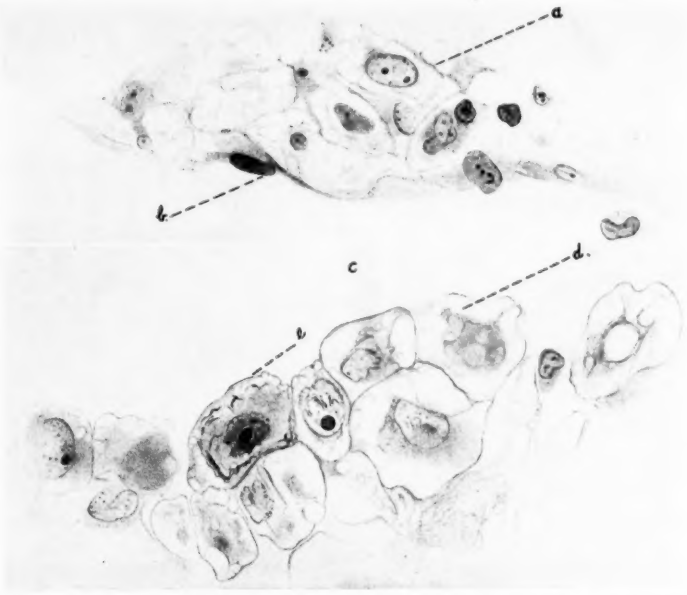

Fig. 6. Camera lucida drawing of venous space in penetration zone. *a*, Endometrial stromal cells; *b*, endothelial lining of venous space; *c*, lumen of venous sinus; *d*, cytotrophoblast replacing endothelial wall; *e*, cytotrophoblastic cell with mitochondria. ×725.

processes have been noted by Jung, Greenhill, Beneke, Marchand, and others. Peters believes these irregular borders are not prickle processes but rather a frayed deposit on the surface. The masses penetrating deepest into the maternal tissue in our ovum do not have these borders, and Bryce-Teacher report similar findings. Numerous masses contain lipoid droplets stained with both scarlet red and osmic acid (Fig. 9). In the penetration zone many syncytial masses with brush borders contain large and small vacuoles. In sections fixed and stained for lipoids, these vacuolated regions do not stain. It is probable that the brush borders are associated with phagocytic activity of the cell masses as suggested by Bartelmez.

In the penetration zone, *Zwischenzone*, or zone of necrosis, Grosser reports an abrupt transition from the trophoblast to the maternal tissue in the Kleinhans ovum, and believes the maternal tissue is not destroyed but merely pushed outward. Veit, Strahl-Beneke, and P. Meyer also note this outward displacement. Streeter states there is no destruction or ingestion of maternal stroma cells in the Miller ovum. On the other hand, Bryce and

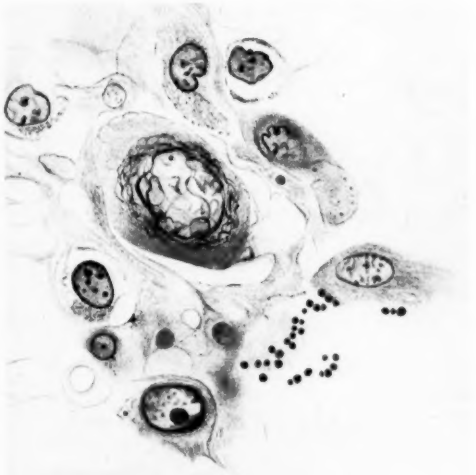

Fig. 7. Drawing of a section containing a fetal wandering cell with mitochondria amidst maternal cells. (Stained with aniline acid fuchsin and methyl green.) Camera lucida. ×1065.

Fig. 8. Photomicrograph of syncytial mass containing mitochondria. (×710, retouched.)

Fig. 9. Photomicrograph of a syncytial mass free in the intervillous space with a brush border and osmic reduced lipoid droplets. ×495.

Teacher observe in an older ovum a marked necrosis at the places where the syncytium comes into contact with the maternal tissue. Jung also believes there is necrosis of the maternal tissue. In the ovum reported here, both degenerative changes in the maternal and fetal tissues and outward pressure are observed. In the penetration zone, the cells of the cytotrophoblast replace the endothelial walls of some maternal capillaries on the fetal side, the endothelial cells on the maternal side remaining intact (Fig. 6). Often cytotrophoblastic cells are adjacent to degenerating endometrial glands with no syncytium in the vicinity. The latter is described also by Grosser. In many places, the maternal capillaries are compressed by the cytotrophoblast, indicating an outward pressure exerted by the growing ovum. The curving of the endometrial vessels and glands about the blastocyst denotes such pressure more conclusively.

The degree of leucocytic invasion through the zone varies in the different ova described. Streeter and Grosser state that there is a moderate invasion in the Miller and Kleinhans ova, both of which are young. Frassi, Jung, Bryce-Teacher, and V. Moellendorff observe quite extensive invasions. Frassi believes the invasion to be due to the presence of the parasitic egg or foreign body, while Jung thinks it the result of tissue necrosis. The invasion in many instances occurs chiefly in the decidua capsularis as in the normal ovum studied here. Even in this region, however, the invasion is slight. Through the decidua marginalis and basilis leucocytes are rare. They are few even in those places in the penetration zone where degenerative changes are most evident. Such predominance in the capsularis suggests that the leucocytes are concerned in the retraction and degeneration of that portion of the decidua. In support of this contention is the notable increase of leucocytes through the capsularis as it disappears in the older ova. Extensive invasions of leucocytes recorded in some ova in contrast to the slight and restricted invasion in normal ova point strongly toward some pathological change. This conclusion was upheld by the report of a chronic metritis in the Frassi ovum and abortions in the Bryce-Teacher and V. Moellendorff specimens.

Fibrin and fibrinoid are described in the penetration zone of many ova. Grosser urges that the term fibrin be applied only to the coagulum arising from the blood and tissue juices; fibrinoid, he states, is formed by degeneration of maternal tissue and the trophoblast. Bryce-Teacher and Moellendorff believe that the fibrinoid originates from maternal tissue, while Peters and Schlagenhauer-Verocay advocate a syncytial origin. Jung, Frassi, and Bryce-Teacher (1924) think as Grosser did that both syncytium and degenerating maternal tissue give rise to fibri-

noid. In some places formation of fibrinoid from degenerating syncytium is noted. Small amounts are evident, scattered through the advancing cytotrophoblast from which it apparently originates. In other places, the origin is undoubtedly in degenerating maternal cells at the boundary zone. In contrast to the description by Bryce and Teacher, and Jung, in which the fibrinoid is arranged in a layer completely around the ova, it is found only in occasional places in our ovum, while in the Peters' ovum it is entirely wanting. When it occurs, it is located at the junction of the decidua and the cytotrophoblast which it separates sharply. The layer is usually thin. In Greenhill's specimen, fibrinoid was being engulfed by the syncytium.

Fibrin occurs mainly in the formation of thrombi. In many places a capillary opens into the intervillous space, one endothelial wall is lost and the other continues along the edge of the normal decidua. Adherent for a considerable distance along this remaining capillary wall is a laminated thrombus made of fibrin, and white and red blood cells. Fibrin is located only in the vessels in the penetration zone.

SUMMARY

1. A normal and anatomically complete human ovum, age 18½ days, is described (Fig. 1).

2. The tissues were fixed in various solutions within 10 minutes after the clamping of the maternal blood supply.

3. An accurate and valuable clinical history is given.

4. The embryonic disc is slightly oval and contains:

a. The earliest stage in formation of a neurenteric canal so far described for the human;

b. A primitive streak and groove (Figure 1.);

c. A Hensen's node;

d. A cloacal membrane;

e. An allantois.

5. The villi surround the entire blastocyst (Fig. 1). Some are branched (Fig. 1). There are a few anchoring villi (Fig. 2).

6. Blood vessel formations arise *in situ*. They are identified in the villi, chorionic membrane, body stalk, and yolk sac wall (Fig. 3). There are primitive blood cells in the vessel formations of the yolk sac (Fig. 3).

7. The cytotrophoblast is of fetal origin (Fig. 2) and contains glycogen. In it there is no reticular framework in sections stained by Bielschowsky's silver method (Fig. 4).

8. Two types of fetal wandering cells develop from the cytotrophoblast. Both contain glycogen and mitochondria. The latter are stained as thin rods and filaments (Figs. 5 and 7).

9. The syncytium originates from the cytotrophoblast and Langhans' cells in a similar manner (Figs. 2 and 8). The mitochondria stain as thin threads (Fig. 8). Many syncytial masses have brush borders (Fig. 9).

10. In the penetration zone there is degeneration of maternal tissue (Fig. 4) as well as an outward pressure exerted by the growing blastocyst (Fig. 1).

11. The slight leucocytic infiltration in the implantation site is limited principally to the decidua capsularis.

12. Fibrinoid is formed from both fetal and maternal tissues in the penetration zone.

We wish to express our appreciation for the valuable suggestions and aid given by Dr. George W. Bartelmez.

BIBLIOGRAPHY

1. Allen, Pratt, Bland, and Newell. J. Am. M. Ass., 1928, 91: 1018.
2. Bryce-Teacher. An early ovum imbedded in the decidua. (Contributions to the study of the early development and imbedding of the human ovum, University of Glasgow Press), 1908.
3. Idem. Tr. Roy. Soc. Edinburgh, 1924, 53: pt. iii, 533–567.
4. Idem. M'Intyre ovum. Tr. Roy. Soc. Edinb., 1924, 53: pt. iii, 546.
5. Debeyre, A. J. anat. et d. Physiol., 1912, 48: 448–515.
6. Eternod, A. C. F. Arch. ital. de biol., 1894, 21: xii-xiv.
7. Falkiner, N. J. Obst. & Gynæc., 1932, 39: 471.
8. Fetzer. Anat. Anz., 1910, 37: Erg.-Heft, 116.
9. Frassi, L. Arch. f. mikr. Anat. u. Entwick., 1908, 70: 492–505.
10. Giacomini. Arch. ital. de biol., 1898, 29: 1–22.
11. Greenhill, J. P. Surg., Gynec. & Obst., 1927, 45: 493.
12. Grosser, O. Anat. Hefte, 1931, 47: 649.
13. Idem. Fruehentwicklung Eihautbildung und Placentation des Menschen und der Saeugetiere. Deutsch. Frauenheilkunde Geburtshilfe, Gynaek. u. Nachbargebiete, 1927, vol. 5.
14. Heine and Hofbauer. Ztschr. f. Geburtsh. u. Gynaek., 1911, 68: 665–688.
15. Herzog, M. Am. J. Anat., 1909, 9: 361–400.

16. HEUSER, C. H. Contributions to Embryology, 1932, No. 138, p. 251–267.
17. HEUKELOM, S. VON Arch. f. Anat. u. Entwcklngsgesch., 1898, p. 1.
18. INGALLS. Contributions to Embryology. Carnegie Inst., 1918, 7: No. 23, 111.
19. JOHNSTONE, R. W. J. Obst. & Gynæc., Brit. Emp., 1914, 25: 231.
20. JUNG, P. Beitraege zur fruehesten Eieinbettung beim menschlichen Weibe. Berlin, 1908.
21. KEIBEL. Arch. f. Anat. u. Physiol., Anat. abth., 1898, p. 250.
22. KINDRED, J. E. Goodwin ovum. Am. J. Anat., 1933, 53: 221.
23. LINZENMEIER, G. Arch. f. Gynaek., 1914, 102: 1–17.
24. MERTTENS, J. Ztschr. f. Geburtsh. u. Gynaek., 1894, 30: 1–97.
25. MEYER, P. Arch. f. Gynaek., 1924, 122: 38.
26. MILLER. Berl. klin. Wchnschr., 1913, 50: 865.
27. MILLER, A. G. Surg., Gynec. & Obst., 1933, 56: 1020.
28. MINOT, C. S. Tr. Am. Gynec. Soc. Phila., 1904, 29: 395.
29. MOENCH. Am. J. Obst. & Gynec., 1927, 13: 334.
30. Idem. J. Am. M. Ass., 1930, 94: 478.
31. MOELLENDORFF, W. v. Ztschr. f. Anat. u. Entwcklngsgesch., 1921, 62: 352–405.
32. PETERS, H. Ueber die Einbettung des menschlichen Eies. Leipzig and Vienna: Franz Deutsch, 1899
33. REICHERT, C. B. Phys. u. med. Abhandl. d. kgl. Akad. der Wiss. zu Berlin, 1873.
34. ROSSI DORIA, T. Arch. f. Gynaek., 1905, 76: 433.
35. SCHLAGENHAUFER and VEROCAY. Arch. f. Gynaek., 1916, 105: 151.
36. SPEE, GRAF. v. Arch. f. Anat. u. Entwcklngsgesch., 1896, p. 1.
37. STRAHL, H. Anat. Hefte, 1916, 54: 115.
38. STRAHL and BENEKE. Ein junger menschlicher Embryo. Wiesbaden: Bergmann, 1910.
39. STREETER, G. L. Mateer ovum. Cont. to Embryo., No. 43, Publication No. 272, p. 389, 1920.
40. Idem. Miller embryo. Contribution to Embryology, No. 92, Publication No. 363, p. 31–48, 1926.
41. TEACHER, J. H. J. Obst. & Gynæc., Brit. Emp., 1924, 31: 166–217.

STUDIES ON ABSORPTION AND EXCRETION IN SEGMENTS OF THE COLON OF MAN[1]

FILLMORE S. CURRY, M.D., ROCHESTER, MINNESOTA
Fellow in Surgery, The Mayo Foundation

J. ARNOLD BARGEN, M.D., ROCHESTER, MINNESOTA
Division of Medicine, The Mayo Clinic

MUCH conflicting experimental evidence exists concerning the absorption of substances other than water by the large intestine. While we were working with a large group of colostomized patients on the combined intestinal service of the Mayo Clinic, it occurred to us that they presented conditions ideally suited to the elimination of the usual fallacies inherent in investigations of colonic absorption, and that, without inconvenience or danger to patients, observations could be made which would be of benefit to all patients. The particular advantages offered by colostomized patients were as follows: (1) The omnivorous colon of man could be studied, rather than the colons of strictly carnivorous or strictly herbivorous animals. (2) The divided colon would prevent error due to regurgitation of the clysma into the absorbing ileum. (3) Short distal segments could be thoroughly evacuated, thereby eliminating any errors due to failure to recover unabsorbed fractions. (4) Thorough cleansing of the easily accessible, short, distal segment would prevent bacterial fermentation in experiments with carbohydrates.

Test substances were chosen with a view to obtaining additional evidence of absorption other than disappearance from the colonic lumen, as well as for utility of these substances otherwise. For these purposes, a number of observations were made, using methylene blue, atropine, glucose, sucrose, and arsenic. Experiments were also performed to determine whether some of these substances, orally or intravenously introduced, would be excreted by the colonic segments.

METHOD

The distal colonic segment was thoroughly cleansed by irrigations with warm tap water; rubber catheters were used, as is illustrated in Figure 1. That this cleansing process was effectual is evidenced by the fact that the content of a segment, removed after cleansing, failed to cause any loss of fermentation, when incubated for 4 hours at 37 degrees C. with 5 grams of glucose.

Following the process of cleansing, the substance to be tested was instilled in solution through the rubber catheter, and left in the segment for the duration of the observation, as determined by its nature. At the end of this time, the unabsorbed fraction was removed by irrigation, and its quantity determined. That the unabsorbed fraction could effectually be removed in this manner was demonstrated by instilling 30 milligrams of arsenic as neoarsphenamine, in solution, and immediately removing it by irrigation with 1,000 cubic centimeters of water. Analysis of this returned fluid by the Osterberg modification of the Gutzeit method resulted in recovery of 97 per cent of the instilled arsenic.

ABSORPTION

Results with methylene blue are given in Table I; those with atropine, in Table II, and those with glucose in Table III.

To determine metabolic factors during the disappearance of glucose from the colonic segments, observations were made on 3 individuals, free of diabetes, on whom colostomy had been performed at the level of the sigmoid; on one individual, who had diabetes graded 3, on whom colostomy had been performed at the level of the sigmoid; and on one individual who had undergone obstructive resection at the level of the sigmoid and who had questionable latent diabetes. Under basal conditions, estimations of the respiratory quotient and heat production, in calories per square meter per hour, were made by the gasometer method (2), and the values for blood sugar were determined by the Folin-Wu method. Following introduction of 30 or 50 grams of glucose into

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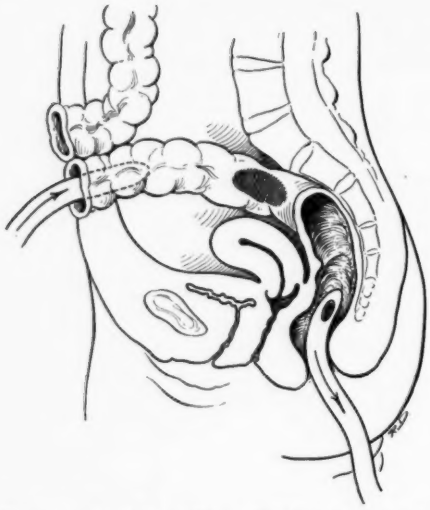

Fig. 1. Anatomical condition after double barrel or loop colostomy, and method of using catheters.

the distal colonic segment, the same determinations were made at hourly intervals for 3 hours, with an additional determination of blood sugar at the first half hour. Table IV shows that in each case mentioned in the foregoing there was an increase in heat production, and in 3 instances there was an increase in respiratory quotient above the basal levels at some point during the disappearance of 9.42 to 48.75 grams of glucose from the distal colonic segments.

Among individuals whose carbohydrate metabolism was not impaired, the values for blood sugar maintained a level or fell slightly, but among individuals who had diabetes, definite increases in values for blood sugar accompanied the absorption of the glucose (Table IV).

The metabolic changes in Case 20, graphically represented, are shown in Figure 2.

Sucrose administered parenterally to man, is not utilized, but it has been shown by Keith, Wakefield and Power that 97 per cent to 98 per cent of it is excreted in the urine within 24 hours. If sucrose is instilled into distal segments of the colon, its subsequent excretion in the urine will be evidence of its absorption by the colon. The invertase hydrolysis method of determination of sucrose, as described by Jolliffe, Shannon and Smith, was employed.

TABLE I.—ABSORPTION OF METHYLENE BLUE

Case	Operation performed	Methylene blue instilled	Time, hours	Urine
1	Type X colostomy at sigmoid	1 gm. per rectum	24	Green
2	Type X colostomy at sigmoid	1 gm. per rectum	4	Green
3	Loop colostomy at sigmoid	1 gm. into lower loop	12	Green

TABLE II.— ABSORPTION OF 1/75 GRAIN (0.00086 GM.) ATROPINE INSTILLED INTO LOWER LOOP

Case	Operation performed	Time, hours	Physiological response		
			Salivation	Pupils	Pulse rate, beats per minute
4	Loop colostomy at sigmoid	½	No effect	No effect	
		1½	Dry mouth	No effect	
		3	Dry mouth	Pupils dilated	
5	Loop colostomy at sigmoid	1½	No effect	No effect	
		2¾	Dry mouth	No effect	
		3¼	Dry mouth	No effect	
6	Loop colostomy at sigmoid	3	Dry mouth	Pupils dilated	
7	Mikulicz operation on descending colon	½	No effect	No effect	84
		1	No effect	No effect	88
		1½	Dry mouth	No effect	90
		2	Dry mouth	Pupils dilated	88
		2¼	Dry mouth	Pupils dilated	90
8	Obstructive resection at sigmoid	½	No effect	No effect	82
		1	No effect	No effect	90
		1½	No effect	No effect	88
		2	Dry mouth	Pupils dilated	86

Two observations on individuals who had undergone colostomy at the level of the sigmoid showed that following instillation of 5 grams of sucrose into the distal colonic segment, urinary excretion of sucrose immediately began; 36 milligrams were recovered in 1 hour and 29 milligrams in 2½ hours, in the urine of the 2 subjects. Following removal of the sucrose from the colonic segment, urinary excretion of sucrose abruptly ceased. These

TABLE III.—ABSORPTION OF GLUCOSE

Case	Operation performed	Glucose instilled	Time, hours	Glucose recovered	Absorbed, per cent
9	Obstructive resection at sigmoid	20 gm. into distal loop	5	0	100
10	Type X colostomy at sigmoid	20 gm. per rectum	3	11.87	40.7
11	Type X colostomy at sigmoid	20 gm. per rectum	3	7.8	61.0
12	Type X colostomy at sigmoid	15 gm. per rectum	3	4.4	70.4
13	Sigmoid loop colostomy	20 gm. into distal loop	3	1.17	94.2
14	Sigmoid loop colostomy	16 gm. into distal loop	3	0.27	98.19
15	Colostomy at middle of descending colon	20 gm. per rectum	3	5.8	71.0
16	Loop colostomy at transverse colon	20 gm. into distal loop	3	0.19	99.05
17	Cæcostomy	20 gm. into cæcal stoma	3	0	100.0
18	Cæcostomy	30 gm. into cæcal stoma	3	0	100.0

observations were not recorded in Tables V or VI.

Observations made on an individual who had undergone colostomy at the level of the sigmoid disclosed that 5 grams of sucrose, instilled into the distal colonic segment, resulted in urinary excretion of sucrose, and that this excretion continued for 48 hours; 382 milligrams were excreted in the first 24 hours, and 273 milligrams in the second 24 hours. This indicates the slowness of absorption of sucrose. The individual mentioned in the foregoing was 1 of 5 who had undergone colostomy at levels ranging from the sigmoid to that of the middle of the transverse colon. Excretion of sucrose in the urine ranged from 2.6 per cent to 12.5 per cent in 24 hours, and from 13.1 per cent to 19.3 per cent in 48 hours; the percentages are based on amounts instilled into the distal segments of colon. It was observed that the higher the colostomy, and thus the larger the absorbing surface of colon, the smaller was the fraction of the total amount of sucrose instilled which was excreted in the urine. This suggested that much of the sucrose not recovered in the urine might have been hydrolyzed to dextrose and levulose, and absorbed as such, since only small

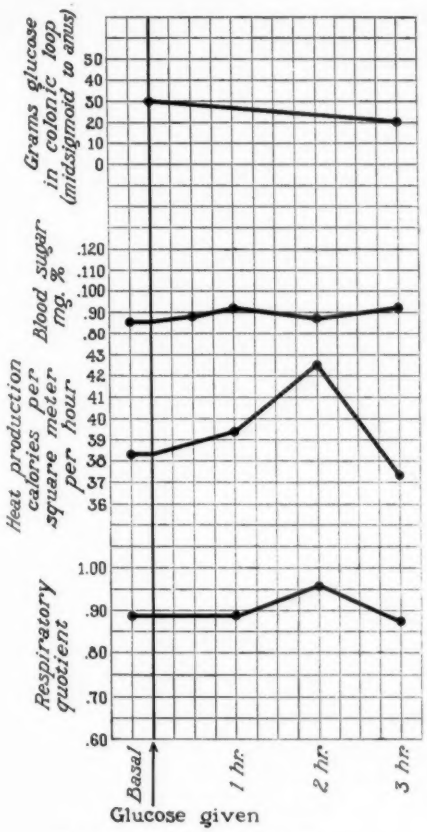

Fig. 2. Metabolic changes in Case 20.

fractions, ranging from 0.023 grams to 0.135 grams remained in the colonic segments at the end of the observation (Table V).

Arsenic instilled as neoarsphenamine, in quantities of 0.15 grams, into the distal colonic segments of 7 persons who had undergone colostomy at the level of the sigmoid, resulted in the disappearance of 25 per cent to 100 per cent of the instilled arsenic within 4 hours; the arsenic of the residual fraction was determined by the Osterberg modification of the Gutzeit method. Of arsenic instilled into 2 persons who had undergone cæcostomy, 69 per cent and 100 per cent, respectively, disappeared in 4 hours. Excretion of arsenic in the urine did not occur in these experiments. However, when the amount of neoarsphenamine instilled

TABLE IV.—ABSORPTION OF GLUCOSE; METABOLIC FACTORS

Case	Operation performed	Glucose instilled per rectum, gm.	Hours after instillation	Blood sugar, mgm. per 100 c.cm.	Respiratory quotient	Calories per sq. meter per hour	Glucose recovered, gm.	Glucose apparently absorbed, gm.
19	Loop colostomy at sigmoid	50		Basal 0.108	0.87	38.1		
			½	0.105				
			1	0.108	0.79	35.5		
			2	0.105	0.87	41.2		
			3	0.104	0.88	40.7	4.16	45.84
20	Loop colostomy at sigmoid	30		Basal 0.086	0.89	38.3		
			½	0.088				
			1	0.092	0.89	39.4		
			2	0.087	0.96	42.6		
			3	0.092	0.85	37.4	20.58	9.42
21	Obstructive resection at sigmoid. Questionable latent diabetes	50		Basal 0.100	0.74	36.7		
			½	0.097				
			1	0.094	0.75	37.8		
			2	0.086	0.78	35.7		
			3	0.087	0.75	37.4	1.25	48.75
22	Obstructive resection at sigmoid	50		Basal 0.107	0.88	35.6		
			½	0.100				
			1	0.099	0.82	36.1		
			2	0.096	0.75	32.8		
			3	0.093	0.81	31.9	2	48
23	Loop colostomy at sigmoid. Diabetes grade 3	50		Basal 0.214	0.82	36.8		
			½	0.208				
			1	0.210	0.81	34.5		
			2	0.224	0.82	37.5	Expelled	
			3	0.221	0.70	35.5	? Grams	
		50		Basal 0.226				
			½	0.250				
			1	0.263				
			2	0.250				
			3	0.250			3.58	46.42

was increased to 0.6 grams, and the duration of the experiment was increased to several days, as was done in 2 cases in which colostomy had been performed at the level of the sigmoid, it was found that subsequent to its instillation in the distal colonic segment, arsenic was excreted in both the urine and the stools from the proximal segment of colon, in amounts ranging from 0.44 milligrams to 1.5 milligrams per 24 hours in the urine, and 0.87 milligrams to 1.0 milligrams per 24 hours in the stools (for arsenic absorption, see Tables VI and VII).

EXCRETION

Certain minerals are known to be excreted in the stools. To determine whether distal segments of the colon take part in this excretory function, in relation to the test substances employed, was the reason for further investigation. For this purpose the test substances were introduced orally or intravenously, and washings of the distal colonic segment were analyzed at intervals thereafter.

Methylene blue, orally administered in amounts ranging from 1 to 5 grains (0.065 to 0.3 gram) was not excreted by the distal part

TABLE V.—SUCROSE ABSORPTION

Case	Operation performed	Sucrose instilled per rectum, gm.	Hours after instillation	Sucrose recovered in urine, gm.	Sucrose excreted, per cent	Sucrose remaining in segment, gm.
24	Sigmoid loop colostomy	5	4	0.080		
			8	0.113		
			24	0.189	7.6	
			48	0.273	13.1	0
25	Sigmoid single barrel colostomy	5	21	0.625	12.5	0.135
26	Sigmoid loop colostomy	5	24	0.6075	12.15	
			48	0.359	19.33	0.023
27	Descending loop colostomy	10	24	0.492	4.9	0.024
28	Obstructive resection transverse	5	24	0.133	2.6	0.031

of the colon in the following 5 hours, although urinary excretion of the dye occurred at that time.

Glucose, intravenously administered in amounts of 25 grams, was not excreted by the distal part of the colon.

Sucrose, intravenously administered in amounts of 5 grams, was not excreted by the colon in the subsequent 18 or 19 hours, although urinary excretion of 87 per cent to 89 per cent of the administered amount occurred during that time.

Results with arsenic are given in Table VIII.

TABLE VI.—ABSORPTION OF ARSENIC IN FOUR HOURS FOLLOWING INSTILLATION OF 0.15 GRAM OF NEOARSPHENAMINE PER RECTUM

Case	Operation performed	Arsenic recovered from colonic segment mgm.*	Arsenic apparently absorbed, per cent
29	Loop colostomy at sigmoid	22.5	25.0
30	Loop colostomy at sigmoid	12.2	59.4
31	Loop colostomy at sigmoid	8.7	71.0
32	Loop colostomy at sigmoid	7.0	76.7
3	Loop colostomy at sigmoid	1.9	93.7
34	Loop colostomy at sigmoid	0	100.0
35	Loop colostomy at sigmoid	0	100.0
36	Cæcostomy	9.3	69.0
37	Cæcostomy	0	100.0

*There was no arsenic in the urine either before or after instillation of arsphenamine.

TABLE VII.—ABSORPTION OF ARSENIC FOLLOWING INSTILLATION OF 0.6 GRAM OF NEOARSPHENAMINE PER RECTUM

Case	Date	Operation performed	Arsenic in urine after instillation, mgm.*	Arsenic in discharge from proximal segment, mgm.	Arsenic recovered from distal segment, mgm.
38	9- 1-32	Obstructive resection of sigmoid			
	9- 2-32		0.44		
	9- 5-32			0.87	2.4
39	8-30-32	Sigmoid loop colostomy		0	
	9 1-32				
	9- 2-32		1.5		
	9- 3-32			1.0	6.9

*There was no arsenic in the urine before instillation of arsphenamine.

COMMENT

The undoubted functions of the colon consist of storage and propulsion of the stool, secretion of mucus to facilitate its passage, and absorption of water (17, 24). There is additional experimental evidence to indicate that from cæcum to anus definite amounts of protein, carbohydrate, salts, metals, anæsthetics, and drugs may be absorbed (4, 5, 7, 22, 27, 32, 33). Bacteria may be absorbed rapidly from the colon, and experiments on animals indicate that rectally introduced glucose results in a greater deposit of carbohydrate in the liver than occurs after its intravenous administration (8, 24, 28).

Functionally the proximal and distal halves of the colon are regarded as dual organs. The proximal half is regarded as the absorptive portion, and the distal half as the organ of storage and propulsion. This division of function is based on the following observations: (1) The proximal part of the colon is developed from the midgut along with the absorptive small intestine, while the distal part is derived from the hindgut. (2) The proximal part of the colon is of larger caliber, and its walls are thinner than the smaller, thick walled, distal portion. (3) The prevailing types of movement in the proximal part of the colon, particularly at the cæcum, are churning and antiperistalsis, whereas in the distal part the prevailing type of movement is propulsive. (4) The content of the proximal part of the colon

TABLE VIII.—EXCRETION OF ARSENIC AFTER ADMINISTRATION BY MOUTH OF TWO TABLETS OF TREPARSOL

Case	Date	Operation performed	Arsenic in urine mgm.	Arsenic excreted by distal segment of colon, mgm.
40	10-12-32	Type X colostomy at sigmoid	0	
	10-13-32			
	10-13-32		6.1	Trace
	10-14-32			
	10-14-32		0.3	
	10-15-32			
	10-15-32		0	0
	10-15-32			
	10-16-32		0	
40	10-17-32	Subtotal colectomy with ileostomy	0	
	10-17-32			0.3
	10-18-32			
	10-18-32		0.8	5.4
	10-19-32			
	10-19-32		0.25	0.5
	10-20-32			
	10-20-32		0.5	0
	10-21-32			

is liquid, whereas that of the distal part is solid or semisolid.

Opinion is still divided as to whether material, other than water, which disappears from the lumen of the colon, is actually absorbed. It has been pointed out that the major fallacies in the assumption that colonic absorption is the cause of this disappearance, are: (1) the probability of antiperistalsis carrying the test substance up into the absorbing ileum; (2) the inability completely to cleanse the undivided colon, and the consequent questionably complete removal of the unabsorbed fraction of test substance; and (3) the possibility of destruction of the test substance by bacterial action.

In our work these objections were overcome by: (1) the operative division of the colon, which precluded the possibility of loss by antiperistalsis; (2) the shortness of the colonic segment, from which a test substance could be completely removed immediately after its introduction; (3) the possibility of complete cleansing of the easily accessible colonic segment, so that the remaining intestinal content is incapable of fermenting glucose by incubation *in vitro;* (4) the use of further criteria of absorption, other than disappearance of the test substance from the colonic lumen.

The further criteria just mentioned require comment. The evidences of absorption of methylene blue, of atropine, and of arsenic, which were employed, have been recorded in applicable tables.

Much dissenting opinion exists over the question of colonic absorption of glucose (3, 4, 6, 9, 10, 11, 12, 16, 17, 18, 20, 21, 23, 25, 26, 27, 28, 29, 30, 31). Failure of values for blood sugar in the peripheral blood to increase during the disappearance of glucose from the lumen of the colon has been the basis of some conclusions as to the failure of the colon to absorb glucose. Actually, if the factors by means of which sugar is removed from the blood stream are not impaired, the values for peripheral blood sugar would be expected to be unaltered, or to be perhaps slightly reduced, due to pancreatic stimulation, during the colonic absorption of glucose. This is what occurred during our observations of subjects who were free of diabetes. On the other hand, in the observations on a diabetic subject, the values for peripheral blood sugar definitely increased during the absorption of glucose from the colonic segment. In addition, increases above the basal level, in the respiratory quotient or in heat production, in calories per square meter per hour, or in both, occurred at some time during the colonic absorption of glucose, in all observations.

If a sugar which is not metabolized in the body is absorbed unchanged by a colonic segment, its subsequent excretion into the urine, and its recovery therefrom, is definite proof of absorption. For that purpose sucrose was instilled into distal colonic loops and recovered unchanged, in the urine, in significant amounts in all observations. Absorption of this substance was shown to be extremely slow, since urinary excretion, although beginning within an hour from the time of introduction of the sucrose into the colonic loop, continued for 48 hours, but could be terminated by removing the sucrose from the colon. Only a portion of

the instilled sucrose was absorbed as such by the colonic segment. It is possible that the remainder may have been hydrolyzed to dextrose and levulose and absorbed as such.

Numerous metals and metallic salts have been shown to be excreted in the fæces. Our work on excretion was designed to determine whether the same substances shown to be absorbed by the distal part of the colon, were excreted by the same segment when introduced orally or intravenously. The results with methylene blue, glucose, sucrose and arsenic have been presented.

CONCLUSIONS

Distal segments of the generally regarded least absorptive or distal half of the colon of man were shown to absorb methylene blue, which subsequently was excreted in the urine; atropine, which caused pupillary dilatation and decreased salivation; sucrose, which subsequently was excreted in the urine; arsenic as neoarsphenamine, which subsequently was excreted in the urine and in the stools from the proximal part of the intestine; and glucose, which disappeared from the colonic segment, accompanied by an increased respiratory quotient or increased heat production, or both. In the presence of impaired utilization of carbohydrate, increases in values for peripheral blood sugar accompanied this process.

Distal segments of the colon of man did not excrete: methylene blue, which had been orally administered in amounts sufficient to appear in the urine; glucose, when 25 grams of it had been intravenously administered; sucrose, when 5 grams of it had been intravenously administered. Arsenic, when administered orally as treparsol, was excreted by distal colonic segments in amounts which in some instances exceeded the urinary excretion over the same period of time.

BIBLIOGRAPHY

1. Bine, Rene, and Schmoll, Emile. The treatment of gastric and duodenal ulcer. Calif. State J. M., 1914, 12:361-366.
2. Boothby, W. M., and Sandiford, Irene. Laboratory Manual of the Technic of Basal Metabolic Rate Determinations. Philadelphia: W. B. Saunders, 1920.
3. Campbell, H. F. Rectal alimentation in the nausea and inanition of pregnancy. Intestinal inhaustion, an important factor and the true solution of its efficiency. Tr. Am. Gynec. Soc., 1878, 3:268–298.
4. Carpenter, T. M. Human metabolism with enemata of alcohol, dextrose and levulose. Carnegie Inst., 1925.
5. Czerny, V. v., and Latschenberger, J. Physiologische Untersuchungen ueber die Verdauung und Resorption im Dickdarm des Menschen. Virchow's Arch., 1874, 59:161–190.
6. Ebeling, W. W. Absorption of dextrose from the colon. Arch. Surg., 1933, 26:134–152.
7. Edsall, D. L., and Miller, C. W. A study of two cases nourished exclusively per rectum; with a determination of absorption, nitrogen-metabolism and intestinal putrefaction. Tr. Coll. Phys. Phila., 1902, 24:225–246.
8. Fischer, Virginia. Absorption of yeast from the large intestine. Proc. Soc. Exper. Biol. & Med., 1932, 29:490–494.
9. Franke, Walter, and Wagner, R. J. Studies of the fermentable blood sugar after parenteral and rectal administration of glucose. J. Met. Research, 1924, 6:375–391.
10. Halasz, Aladar von. Die Resorption und das biologische Verhalten der verschiedenen Zuckerarten im Dickdarme. Deutsch. Arch. f. klin. Med., 1910, 98:433–474.
11. Hari, Paul, and Halasz, Aladar v. Ueber die Resorption des rectal eingefuehrten Traubenzuckers. Biochem. Ztschr., 1918, 88:337–344.
12. Hubbard, R. S., and Wilson, D. C. An experiment on the absorption of glucose given by rectum. Proc. Soc. Exper. Biol. & Med., 1922, 19:292–294.
13. Jolliffe, Norman, Shannon, J. A., and Smith, H. W. The excretion of urine in the dog. III. The use of non-metabolized sugars in the measurement of the glomerular filtrate. Am. J. Physiol., 1932, 100:301–312.
14. Keith, N. M., Wakefield, E. G., and Power, M. H. The excretion and utilization of sucrose when injected intravenously in man. Am. J. Physiol., 1932, 101:63–64.
15. Larson, L. M., and Bargen, J. A. Physiology of the colon. Arch. Surg., 1933, 27:1–50.
16. Levi, David. A note on the glucose enema and its value in postoperative treatment. Brit. J. Surg, 1927, 15:282–285.
17. McNealy, R. W., and Willems, J. D. The absorption of glucose from the colon. Preliminary study of the glucose enema. Surg., Gynec., & Obst., 1929, 49:794–798.
18. Idem. Absorption of dextrose from colon; a study of the effects of chemical excitants and of stimulants on dextrose enema. Arch. Surg., 1931, 22:649–657.
19. Osterberg, A. E. A modification of the electrolytic Gutzeit apparatus for estimation of arsenic in biological material. J. Biol. Chem., 1928, 76:19–22.
20. Perusse, G. L., Jr. The solution of choice in proctoclysis. Surg., Gynec., & Obst., 1932, 54:770–784.
21. Pressman, J. J. The absorption of glucose per rectum. Am. J. Med. Sc., 1930, 179:520–528.
22. Rankin, F. W., Bargen, J. A., and Buie, L. A. The Colon, Rectum, and Anus. Philadelphia: W. B. Saunders, 1932.
23. Reach, Felix. Ueber Resorption von Kohlehydraten von der Schleimhaut des Rectums. Arch. f. exper. Path. u. Pharmakol., 1902, 47:231–249.
24. Rosenfeld, Georg. Ueber die Behandlung der Zuckerkrankheit. Klin. Wchnschr., 1909, 1:957.

25. RUBINO and VARELA. Reaktive Hypoglykaemie durch parenterale Zuckerzufuhr. Klin. Wchnschr., 1922, 1:2370–2374.
26. SCOTT, E. L., and ZWEIGHAFT, J. F. B. Blood sugar in man following the rectal injection of dextrose. Arch. Int. Med., 1932, 49:221–226.
27. SHORT, A. R., and BYWATERS, H. W. Amino-acids and sugars in rectal feeding. Brit. Med. J., 1913, 1:1361–1366.
28. SHUGER, M., and ARNOLD, LLOYD. Absorption of bacteria from large intestine. Proc. Soc. Exper. Biol. & Med., 1932, 29:494–496.
29. DE TAKATS, G. Push fluids; the surgeon's postoperative order. Am. J. Surg., 1931, 11:39–44.
30. TALLERMAN, K. H. Rectal absorption of glucose. Quart. J. Med., 1920, 13:356–362.
31. VARELA and RUBINO. Rektale Dextrosezufuhr und Blutzucker. Med. Klin., 1922, 18:831–833.
32. VOIT, C. Absorption of albuminous matters in the large intestine. Neues Repertorium f. Pharmocie, 17, 4; Practitioner, 1869, 2:370.
33. VOIT, CARL, and BAUER, JOSEPH. Ueber die Aufsauegung im Dick und Duenndarme. Ztschr. f. Biol., 1870; 5:536–570. Jahrb. d. ges. Med., 1872, 134–138.

SOME PRINCIPLES OF LOCAL ANÆSTHESIA

L. ÁDÁM, M.D., BUDAPEST, HUNGARY
Professor of Surgery, University of Budapest

PAIN is a psychic experience well known to all of us (Foerster). Undoubtedly, pain is often a warning that our body or some organ of it is diseased and needs rest. Pain is, however, not always a benefactor; it may also be a useless torturer. As to operative pain and pain of incurable disease, the ancient Hippocratic adage "*divinum est opus sedare dolorem*" has remained valid to this day.

Physical correlative of the psychic experience of pain sensation consists in an excitation process of the afferent nervous system (Foerster).

The nerves supplying the individual organs are for the most part well known; unless they are thoroughly understood, good anæsthesia is impossible. No doubt, there may be a great difference between the sensitiveness of one individual and another or of one organ and another, but if a really good anæsthesia is to be obtained, this difference should not be relied upon, but each individual and each organ should be considered sensitive: not only skin, muscle, fascia, bone, joints, pleura, peritoneum, but also stomach, bowel, bladder, parenchymatous organs, vessels and so on. Sensory nerve fibers can be demonstrated in the stomach, bowel, vessels, lungs and so on—although not in cartilage—but very probably the receptors of the bowel are different from those of the skin. Pressure, crushing, stinging, burning of the skin are painful, whereas the same stimuli cause no pain if applied to the bowel or to the lung. It is likely, however, that contractions, stretching, anæmia of the bowel, sufficient duration and summation of various stimuli, changes in the vicinity, are capable of producing pain.

It must be stressed that even the smallest sensitive field during operation should receive due care. Sensitivity of the smallest spot may spoil the entire effect of anæsthesia, for the patient is not conscious of the painless phases of the operation and remembers only the pain conveyed from the sensitive part.

I have been studying the question of local anæsthesia for more than 25 years. At the surgical clinic of Professor Dollinger we performed 6,000 operations under local anæsthesia—95 per cent of all cases—as reported by Professor Dollinger in 1913 at the International Congress of Surgeons in London. This number has not been reached by any other surgeon as yet. Together with my 1,200 cases operated upon at the Zita Hospital, 7,200 operations have been performed under procaine anæsthesia, tutocaine has been used in 6,675 cases, nupercaine in 4,940, pantocaine in 4,982; this makes a total of 23,797 major operations and if I add our 8,000 operations performed on out-patients, I can report 31,797 operations performed under local anæsthesia, without a single fatality during operation. This is such a great number and the result is so excellent that it seems worth while to draw a few useful conclusions. Methods have been amply commented upon in the works of Schleich, Braun, Reclus, and Pauchet, therefore I only wish to call attention to some practical points.

CHOICE OF ANÆSTHETIC

The first important problem is the choice of a good anæsthetic. Since I had no fatality with procaine, the question may be raised, why I abandoned it and why I later abandoned tutocaine and nupercaine as well. I can easily answer that "better" is the enemy of "good." In any case, it seems worth while to examine this problem more closely.

What is required of a good anæsthetic? This question I answered in my lecture at the Congress in Sopron in 1929 as follows:

1. It must be a substance capable of paralyzing the nerve tissue at a low concentration, without being a protoplasm poison to the other tissues.

2. The anæsthetic possesses a specific affinity to the nerve tissue and if it enters the circulation it may seriously intoxicate the central nervous system, therefore it must be

retained at the site of injection as long as possible.

3. The change brought about in the sensory nerve by the anæsthetic must cease after a certain time without leaving a trace.

4. The anæsthetic must be transformed locally by the tissues in order to be released into the circulation in a detoxified state.

5. From a surgical point of view it is important that it be water-soluble, boilable, and not liable to decomposition during sterilization. It must not irritate the tissues or cause pain on injection. It must mix with epinephrin in order to be retained locally.

Even though an anæsthetic fulfills all these requirements, we must still take into account the fact that the more efficacious an anæsthetic is, the greater its toxicity. In the living organism, however, toxicity of many compounds becomes modified under the influence of certain factors. It must be specially emphasized that the diffusion speed of an aqueous solution depends on the quality of the solved substance, on the permeability of the membranes separating the solutions, and on the concentration of the solution.

The main cause of my changing anæsthetics, therefore, was my endeavor to use substances of the lowest possible effective concentration, in order to depress the diffusion speed. In a major operation 150 to 180 cubic centimeters of anæsthetic solution is required. If a 1 per cent procaine solution is employed, this means not only the introduction of 1.5 to 1.8 grams of foreign substance into the organism, but also the use of a 1 per cent solution, the absorption of which, on account of its relatively high concentration, is quicker than that of a 0.25 per cent tutocaine or a 0.1 per cent pantocaine solution. This will certainly increase the toxicity. That this is true, is evidenced by the fact that palpitation, pallor, diffuse sweating, rapid pulse, even nausea and vomiting during or shortly after anæsthesia were almost constant concomitant symptoms of procaine anæsthesia, whereas since I have used the solutions of low concentration, the symptoms mentioned have become an extremely rare occurrence.

Second, the anatomical site of the operation needs careful consideration. On the head, neck or near the spinal column one cannot, with impunity, use as great quantities of anæsthetic as may be used far from the central nervous system; e.g., on the extremities, whence the anæsthetic must pass many more cells before reaching the central nervous system and in this way be more likely to become thoroughly modified or detoxified.

Not only have intoxications ceased to appear in our patients but better anæsthetic effects are obtained even in the hands of the young members of the staff of my clinic. This improvement, I am convinced, is due not only to ample opportunity afforded staff members to see and to learn the technique of anæsthesia and the suggestive influence on new patients of those already operated on, but also to the fact that a sufficient quantity of this diluted anæsthetic to anæsthetize any operative field may be safely used. Nevertheless I would warn against injecting too great an amount at once; the dose should remain far below the toxic dose. If the patient should feel pain during operation, the few milligrams of anæsthetic which will have been already detoxified allow for the injection of a considerable amount of additional anæsthetic solution. This continuous supplementing dosage, according to the needs, makes it possible to complete under local anæsthesia any operation started under local anæsthesia. The fact that in complicated operations of long duration we do not inject large quantities of anæsthetic at once, may account for our record of not a single fatality in a vast number of cases.

METHODS

With adoption of certain modifications, I returned to and use extensively the Schleich, Hackenbruch, and Oberst methods—the latter, of course, without tourniquet—all methods of nerve block anæsthesia—trigeminal, cervical, Kulenkampff plexus, the Keppler, Haertel methods and so on—carried out as well endoneurally as perineurally. In the abdominal cavity I use the Braun anæsthesia of the solar plexus, of the hypogastric plexus, also parasacral anæsthesia and infiltration of mesenterial attachments. Paravertebral anæsthesia I now use exclusively in kidney operations.

Complicated methods in general are likely to fail. Their drawback is that in case of failure another method has to be resorted to, and this must be one performable in the operative field. By complicated method I do not mean a block anæsthesia in which the nerves are outside the operative field but may be reached without changing the patient's posture to any great extent. In general, anæsthesia should be brought nearer to the field of operation.

I abandoned not only paravertebral anæsthesia, but also trunk anæsthesia of the major and minor splanchnic nerves (suggested formerly by myself), and the solar plexus anæsthesia of Kappis. I do not employ the high sacral anæsthesia as recommended by Schuster, nor the method of pouring anæsthetic solution into the abdominal cavity as suggested by Seidel. I shall not return to spinal anæsthesia and I am not inclined to use even the controllable form as described by Kirschner (control by air sufflation) as long as I hear that there is one fatality in each 300 to 500 cases and that excruciating headaches lasting for days, and bladder paralyses are often observed.

OBJECTIONS AND CONTRA-INDICATIONS TO LOCAL ANÆSTHESIA

What are the drawbacks of local anæsthesia?

It is said that it requires a special training. This is true, but it is not a disadvantage. Moreover, in most operations the methods have been so greatly simplified that they may be easily learned.

Occasionally fall of blood pressure or certain toxic symptoms will occur. These, however, become progressively more uncommon; moreover, they cannot be compared with troubles observed in general anæsthesia.

It has been asserted, too, that some greater vessel may be injured. With some care this can easily be avoided, and even if an injury occurs, it will cause no serious trouble, provided the injury is perceived and no anæsthetic is injected into the vessel. In infiltrating the deep layers I never use too sharp needles and in this way the orientation as to the layers is made easier. Tissue necrosis caused by anæsthetics has also been described; I myself never saw a single case of this and I believe that those who have observed it must have infiltrated tense tissues or used great amounts of some highly concentrated fluid.

Suppuration cannot be placed to the account of local anæsthesia, for both syringe and solution may and should be adequately sterilized.

What are contra-indications for infiltration anæsthesia?

Most treatises on this topic mention malignant tumors, sepsis, inflammatory diseases, youth, and obesity or hysteria in women. In our day a malignant tumor is not considered a contra-indication by the majority of surgeons, for, if performed far enough from the neoplasm, inoculation need not be feared. Moreover, operations for cancer of the tongue, cheeks, tonsils and throat have lost their bad reputation since the introduction of local anæsthesia.

In my opinion, general anæsthesia is contra-indicated in septic patients; as for the rest, I never saw suppuration at the site of the injection.

No doubt active hyperæmia increases excitability of sensory nerves, whereas passive hyperæmia depresses the same. Nevertheless, I do not recommend the classic Oberst anæsthesia, and even less do I recommend applying the constricting bandage to an anæsthetic field, since constriction itself is painful. Many surgeons are disinclined to employ local anæsthesia in inflammatory conditions because they fear that forcing the solution into the tense tissue may cause pain; they are afraid also that infective matter may be conveyed into healthy tissues, and give rise to a spreading infection. I never have been restrained by inflamed tissues from operating under local anæsthesia and I never saw any unfortunate consequence. Of course, if the field is of small size, I prefer circular infiltration in the healthy tissues, or I perform block anæsthesia, if feasible; but if it seems necessary, I do not refrain from infiltrating the inflamed tissue. In such cases I use a very fine needle and I inject the solution at a slow rate. I do not enter healthy regions from inflamed ones. In my experience infiltration of inflamed tissues never caused spreading of the infection; it has rather tended

toward quicker amelioriation or even subsidence of the inflammation, possibly by abolishing pain. Of course I readily admit that there are cases in which a superficial ethyl chloride inhalation is to be preferred to a more complicated local anæsthesia (e.g., mastitis and so on).

Hohmeier and a few other surgeons describe a method of infiltration which consists in pushing the needle forward until bone contact is felt and infiltrating the layers while pulling back the needle. This method is not too gentle. The solution should always precede the needle, because in this way infiltration is entirely painless and injury to vessels is not likely to occur.

Anæsthesia must be induced without causing pain. Methods using intravenous or other kinds of narcosis for performing local anæsthesia are needless. Local anæsthesia needs gentleness, patience, and anatomical knowledge; if it fails the patient should be given ethyl chloride or ether, but he must not be allowed to suffer. I have simplified the technique of inducing anæsthesia to such an extent that the patient feels only one or at most two superficial needle pricks. In this manner I am able to operate on a steadily increasing number of children under local anæsthesia.

I often read that fat or hysterical women are not suited for local anæsthesia. I cannot agree with this. In fat women I consider narcosis contra-indicated, whereas the majority of hysterical women are very well suited for local anæsthesia, especially if they are kept in the hospital for a few days before being operated upon.

I have not observed any untoward effect from block anæsthesia either in diabetic or in arteriosclerotic patients. Epinephrin, however, injected near to necrotic tissues, may cause spread of necrosis.

ADVANTAGES AND ABSOLUTE INDICATIONS

And now, what are the advantages of local anæsthesia? A point of economy is that no medical assistant is needed during operation or until the awakening of the patient. The operation is not complicated by a simultaneous procedure, the narcosis, which is fraught with a graver danger than the operation itself, since, although it is almost out of the control of the operating surgeon, he is nevertheless responsible for its risks.

Local anæsthesia can be employed in all cases in which general anæsthesia would be dangerous. It has a great importance in bone fractures. If 20 cubic centimeters of a 0.1 per cent pantocaine solution is injected between the bone ends, pain and muscular contraction promptly cease and the fracture may be easily and painlessly reduced. No block or circular infiltration anæsthesia is needed. In general medical practice it saves a great deal of suffering. The general practitioner cannot be required to perform under narcosis lumbar or cisternal puncture or puncture of the pleural or peritoneal cavity, of joints, of a paranephritic abscess (nor is the practice indicated), but he should be required to anæsthetize the skin at the puncture site and the entire way of the needle. In this way breakage of needles will be avoided and the patient will not be in fear of a future repetition of the procedure. The argument that the patient has to suffer a prick even if anæsthetized and that a puncture is performed so quickly as to make anæsthesia superfluous does not hold. The single layers, especially the pleura and the peritoneum, are very sensitive, and even after the needle has been introduced, the slightest movement of the needle during tapping may cause considerable pain.

Local anæsthesia is indicated in all operations if there is no particular contra-indication —psychic causes, greater simplicity of general anæsthesia—because it is simpler and safer.

There are certain operations which I never perform under general anæsthesia. In heart disease, emphysema, bronchitis, arteriosclerosis, kidney disease, in impaired liver function or in bad operative risks narcosis is contra-indicated. Cosmetic operations, and interventions that are not absolutely necessary (removal of scars, benign tumors), certain plastic operations, herniorrhaphies—especially umbilical hernias of fat women—I perform exclusively under local anæsthesia, because I consider it inexcusable to expose the patient to the danger of narcosis if the same operation can be performed safely under local anæsthesia. The same applies to trepanation,

OUR CASES SINCE 1926

Type of anæsthesia	Site of operation	Number of cases	
		Local anæsthesia	Local anæsthesia +narcosis
Block anæsthesia	Head	327	13
	Neck	509	none
	Thorax	204	8
	Abdomen	150	22
	Upper extremity	181	4
	Lower extremity	337	3
	Hernia	3,960	6
	Rectum	818	none
Braun solar plexus	Stomach	860	20
	Bile passages	1,053	91
	Spleen	4	none
Mesenterial	Small intestine	91	10
	Colon	121	none
	Appendix	4,018	248
	Female genitalia	20	7
Paravertebral (Rihmer-Noszkav type) (Frigyesi type)	Ribs (thoracoplasty)	81	2
	Kidney	81	12
	Female genitalia	9	1
Parasacral	Vagina	17	none
	Rectum	46	1
	Bladder	23	6
	Prostate	27	5
Total Linear infiltration		12,956 1,773	459 (2.5 per cent)
Total Narcosis	(80.9 per cent) (16.6 per cent)	14,729 3,025	

Total number of operations: 18,213.

operations on the face, mouth, neck, thorax, and the genito-urinary apparatus, which operations I perform almost exclusively under local anæsthesia. I employ narcosis only in certain abdominal operations and in operations on the extremities if local anæsthesia has proved unsatisfactory or if narcosis is simpler and not contra-indicated; in long standing jaundice, however, narcosis may be followed by serious injury to the liver.

I readily admit that postoperative pneumonia is observed also in patients operated upon under local anæsthesia; it shows, however, a more favorable course and is more easily treated. There is no doubt that local anæsthesia is less likely to be followed by postoperative heart, liver, and kidney damage.

It is not fair to compare mortality of operations performed under general and local anæsthesia, respectively, because many poor risks are operated upon under local anæsthesia who were refused operation, or they were operated upon under narcosis and died. In seriously impaired liver function the results of local anæsthesia are conspicuously better than those of general anæsthesia.

What is still to be required of an ideal anæsthetic?

In my opinion it would be of great benefit if the anæsthetic or at least the hypæsthetic effect could be prolonged. The effect is sufficient for the performance of the most extensive operations; it would be desirable, however, if the operative field could be made painless for at least 24 hours.

After narcosis, the patient, being still under the narcotic effect, does not cough; whereas in local anæsthesia, after pain sensation of the wound has returned, the patient does not breathe deeply and does not ventilate his lungs. If, however, the pain could be abolished for 6 to 18 hours, the patient would dare to move, to breathe deeply. In this way many bed sores, many cases of pneumonia could be prevented and the patient could be spared much pain, for pain decreases with each additional hour elapsing after operation. After 24 hours the wound does not ache at all. In my opinion, therefore, after anæsthesia, a painless period lasting 24 hours should be aimed at. In this respect nupercaine opened a new perspective and if we succeed in securing a 24 hour painlessness, the ideal goal of entirely painless operative healing will be reached.

VARIATIONS OF THE FEMALE PELVIS IN RELATION TO LABOR

HERBERT THOMS, M.D., NEW HAVEN, CONNECTICUT
From the Department of Obstetrics and Gynecology, Yale University School of Medicine

VARIATIONS of the female pelvis which are not abnormalities in the usual sense occur with relative frequency, a fact to which I called attention in 1932 (4). A common variation which we have studied is characterized by a shortening of the transverse diameter of the superior strait, often associated with an increased anteroposterior diameter. In such pelves this plane appears essentially round, while in some, the anteroposterior diameter is actually increased over that of the transverse, making the pelvis of the true dolichopellic type described in 1886 by Turner.

In 1933 Caldwell and Moloy reported on the anatomical variations of female pelves and classified them into 4 general groups—the gynecoid, android, anthropoid, and platypelloid types. These authors further subdivided their classification to include pelves which may be admixtures of the types noted and employed such terms as android-anthropoid, android-gynecoid, android-flat, anthropoid-gynecoid, gynecoid-flat, etc. While these designations are interesting and descriptive it is obvious that for general clinical purposes a more simple classification is essential. I have recently suggested that such a classification can be based chiefly upon the general conformation of the superior strait as is shown in the following grouping.

1. *The female type.* The normal female pelvis of other classifications. The superior strait is ovoid in shape, the transverse diameter being more than 1 centimeter longer than the anteroposterior diameter. The pelvis may be classified as large, average, or small, dependent upon the length of the anteroposterior diameter. If this diameter is 12 centimeters or over, the pelvis is designated as large female type. If the diameter is under 10.5 centimeters it is designated as small female type. In rare instances the length of the transverse diameter may be so increased over that of the anteroposterior diameter as to render a distinctly flattened appearance to the superior strait. In any instance therefore where the transverse diameter is longer than the anteroposterior by 3 centimeters or more, such a pelvis is spoken of as flat female type. For example, the anteroposterior diameter being 9.5 centimeters with the transverse diameter 12.5 centimeters, the pelvis would be designated small flat female type.

2. *The round type.* The superior strait in this type has a distinctly round appearance, the transverse diameter predominating in length over the anteroposterior by 1 centimeter or less. The pelvis may be classified as large, average or small, dependent upon the length of the anteroposterior diameter. If this diameter is 13 centimeters or over, the pelvis is designated as large round type. If this diameter is less than 11 centimeters it is designated as small round type.

3. *The anthropoid type.* The superior strait appears elongated anteroposteriorly. The anteroposterior diameter is longer than the transverse. The pelvis may be classified as large, average or small, dependent upon the length of the anteroposterior diameter. If this diameter is 14 centimeters or over the pelvis is designated as large anthropoid type. If this diameter is less than 11.5 centimeters it is designated as small anthropoid type.

To differentiate readily large and small pelves in these types we may summarize as follows:

Large pelves
- Female Type—Anteroposterior diameter of 12 centimeters or over.
- Round Type—Anteroposterior diameter of 13 centimeters or over.
- Anthropoid Type—Anteroposterior diameter of 14 centimeters or over.

Small pelves
- Female Type—Anteroposterior diameter less than 10.5 centimeters.
- Round Type—Anteroposterior diameter less than 11.0 centimeters.
- Anthropoid Type—Anteroposterior diameter less than 11.5 centimeters.

Funnel pelvis

If in any of the types noted above the pelvic outlet presents an intertuberal diameter of 8 centimeters or less, such a pelvis is further designated as funnel. Thus we may employ such terms as small round funnel pelvis, anthropoid funnel pelvis, etc.

In the present communication is included a roentgenometric study of the pelvis in a consecutive series of 135 primiparous patients, and a study of labor in its relationship to the pelvis in 100 of these women who have been delivered in the wards of the hospital.

TABULATION OF PELVIC VARIATIONS ACCORDING TO THE PRESENT CLASSIFICATION

Total number of patients—135: white—115; colored—20.

Pelves of the *female type*—70 or 51.8 per cent	
Average female type	39
Small female type	15
Large female type	7
Average female type funnel	5
Small female type flat	1
Average female type flat	1
Large female type funnel	1
Small flat rachitic	1
Pelves of the *round type*—48 or 35.5 per cent	
Average round type	36
Small round type	2
Large round type	6
Average round type funnel	2
Small round type funnel	2
Pelves of the *anthropoid type*—17 or 12.6 per cent	
Average anthropoid type	12
Small anthropoid type	2
Large anthropoid type	2
Average anthropoid type funnel	1

If we separate the races in this group we find that of the 120 pelves studied in white women, 51.7 per cent were of the female type, 33.3 per cent of the round type and 10.8 per cent of the anthropoid type. In the 20 pelves occurring in colored women we find female type, 40 per cent, round type 40 per cent and anthropoid type, 20 per cent. This increase in the percentage of the latter two types in the colored group is what one might expect in a race which is physically closer to the aboriginal than the white race. Certain phases of this subject have been discussed in a recent article entitled "What is a Normal Pelvis?"(7).

PELVIMETRY

Roentgen pelvimetry. The method of roentgen pelvimetry which has been developed in this clinic is accurate to within 2 millimeters in determining the lengths of the anteroposterior and transverse diameters of the superior strait. This error is of slight significance in practical obstetrics. The method is simple and rapid, has been tested for accuracy in this clinic and elsewhere by means of dried pelves and during laparotomy in living patients, and can be performed by the roentgen technician. The details of the present technique have been recently published and reference is here given (5).

External pelvimetry. From time to time I have expressed my opinion of the inadequacy of external pelvimetry and in 1933 (6) published my results of a survey of 75 pelves measured both by external pelvimetry and by roentgen pelvimetry. My present position is shown by a quotation from this communication.

> One hesitates to express an adverse opinion concerning the time-honored custom of taking external pelvic measurements, yet the facts revealed by roentgenographic studies are impressive and significant. Certainly to classify pelves by means of the four external measurements usually taken is erroneous and illogical. Furthermore, the question may well be raised whether in the absence of roentgenometric methods, external measurements are at all valuable. I must confess that they mean very little to me. It is true that when I find an external conjugate diameter of 18 centimeters or less I entertain the possibility of pelvic contraction but beyond this point I am unwilling to go. In conclusion I must again state my firm belief that scientific obstetrics demands an accurate survey of the pelvis of every primiparous woman, and this ideal may be obtained by only roentgenometric methods.

I think that most obstetrical authorities will agree that the measurement of the external conjugate diameter is assumed to be the most useful of all external measurements of the superior strait. In the light of present and past experience, however, it would seem that it must be used only as a guide post, and that abnormal shortening of this diameter by no means indicates a concomitant shortening of the anteroposterior diameter of the superior strait.

In reviewing the present series of 134 patients, the external conjugate, in 15 instances, was 18 centimeters, with an accompanying true anteroposterior diameter of the superior strait of 11.5, 12.5, 11.0, 11.0, 12.0, 11.5, 10.5, 11.0, 12.25, 11.0, 10.0, 11.0, 10.75, 9.25 and 10.5 centimeters, respectively. In 8 instances

the external conjugate measured 17.5 centimeters with true anteroposterior diameters of 11.0, 11.0, 12.5, 11.5, 11.0, 10.5, 9.5, 9.5. In 5 instances the external conjugate measured 17.0 centimeters with a true anteroposterior diameter of 11.0, 11.0, 12.0, 12.5, 11.5. These figures show the impossibility of establishing any true relationship between the length of the external conjugate diameter and the true anteroposterior diameter of the superior strait.

With regard to external pelvimetry of the pelvic outlet, the situation is different. Here the bony points to be measured are easily palpable externally and our mensuration of the diameters of the outlet should be reasonably accurate. I believe therefore that the most practical methods of determining the dimensions of the female pelvis in the living are those of roentgen pelvimetry of the superior strait and external pelvimetry of the pelvic outlet.

Perhaps at this point a word should be said with regard to the determination of the diagonal conjugate diameter by means of vaginal touch. We have found that in primiparous patients this is usually an unsatisfactory procedure due to the rigidity of the soft parts and to the discomfort experienced by the patient. Furthermore, it is obvious that in most of the round type and anthropoid type pelves, the procedure is of little use as the fingers of the examiner are not, as a rule, sufficiently long to reach the sacral promontory.

In studying the character of the labor in 100 primiparous women whose pelves come under the classification just noted, the following facts were observed.

PELVES OF THE FEMALE TYPE

Of the 49 cases presenting pelves classified as female type (42 white, 7 colored), 39 were delivered spontaneously and 10 by operative procedures. In 7 instances the occiput entered the posterior half of the pelvis (15 per cent of vertex presentations). This occurred 3 times in the average female type, 3 times in the small flat female type and once in the small female type.

PELVES OF THE ROUND TYPE

Of the 37 cases presenting pelves classified as round type (32 white, 5 colored) 26 were delivered spontaneously and 11 by operative procedures. In 7 of this group (7 of 34 vertex presentations, or 20 per cent) the occiput entered the posterior half of the pelvis.

PELVES OF THE ANTHROPOID TYPE

Of the 15 cases presenting pelves classified as anthropoid type (12 white, 3 colored) 12 were delivered spontaneously and 3 by operative procedures. In 8 cases (8 of 14 vertex presentations, or 57 per cent) the occiput entered the posterior half of the pelvis.

DURATION OF LABOR

Many factors influence the duration of labor in primiparous patients, such as the strength and frequency of the uterine contractions, the size of the fetus, the malleability of the fetal head, etc. However, the size and shape of the pelvis is one of the important factors. While no definite conclusions can be drawn from the following data concerning the length of labor in the series in question, the figures as given may be of interest.

	hours
Female type series	
Average duration of labor for the series	16½
Average duration of labor in large type	18½
Average duration of labor in small type	20¾
Round type series	
Average duration of labor for the series	17½
Average duration of labor in large type	15¾
Average duration of labor in small type	24½
Anthropoid type series	
Average duration of labor for the series	13½
Average duration of labor in large type	4¾
Average duration of labor in small type	12¼

OCCIPITOPOSTERIOR POSITIONS

In 1932, I called attention to the intimate association between occipitoposterior varieties and the "transversely contracted" (round and anthropoid type) pelves, and reviewed 16 consecutive cases in which occipitoposterior positions had occurred, consecutively. An analysis of these cases according to the classification given shows the types of pelvis presented.

Average anthropoid type	4
Large anthropoid type	1
Average round type	8
Small round type	2
Small female type with slight asymmetry	1

In the paper noted above the statement was made that "transverse contractions of the

pelvic inlet, either real or relative are far more frequent than hitherto supposed and have a most important place in occipitoposterior positions." In the following year I pointed out that actual or relative shortening of the transverse diameter of the superior strait results in a limitation of space that is relatively greater in the anterior than in the posterior half of this plane and that under these circumstances it seems obvious that the occiput in its descent will enter the pelvis in its posterior half. This viewpoint was substantiated by the opinion of Caldwell and Moloy who state that "in the anthropoid type of pelvis, engagement is possible only in the anteroposterior diameter as compensation exists in the posterior pelvis, the anterior part of the inlet being narrow."

Several observers have pointed out that early in labor an occipitoposterior position is more common than is generally recognized. Thus Potter (3), who, because of his unusual technique of delivery by version and extraction, makes vaginal examinations early in labor, reports in a series of 515 cases an occipitoposterior position in 166 or 32 per cent. Danforth (2) in a recent review of 1,565 cases, noted this position in 443 or 27.1 per cent. My own opinion is that in certain varieties of pelvis such as the anthropoid, round, small female, and flat female types the incidence of this position is very high and that the general incidence early in labor is somewhere between 35 and 50 per cent.

The incidence of occipitoposterior position in pelves of the small female type and the flat female type as noted in 4 cases of the present series deserves comment. In the former the shape of the superior strait usually approximates that seen in the small round pelvis which, I am convinced, favors occipitoposterior position, while in the flat female type the abnormal projection forward of the sacral promontory which characterizes this variety, unquestionably forces the occiput to occupy the posterior half of the pelvis.

The query may well be made as to why in the present series, occipitoposterior position early in labor does not show greater incidence. A number of factors may explain this. In the first place these patients were delivered by the house staff, whose examinations from below are usually limited to rectal touch. It is obvious that many occipitoposterior positions may be thus overlooked, particularly early in labor when the cervix is but partially dilated. Secondly, many patients do not enter the hospital until well advanced in labor, and when seen by the examiner spontaneous internal rotation will have already taken place.

CONCLUSIONS

The present study of the pelvis in 135 primiparous women, 100 of whom have been delivered, emphasizes the following:

1. The incidence of anatomical variations of the pelvis is of frequent and significant occurrence. In this group the so called "normal" female pelvis of other classifications occurred in but 52 per cent of cases.

2. Because of the frequency of the incidence of anatomical variations, a simple, working classification is necessary and the one presented here is both simple and descriptive in its nomenclature.

3. An accurate and practical survey of the female bony pelvis should include roentgen pelvimetry of the pelvic inlet and external pelvimetry of the pelvic outlet.

4. The incidence of occipitoposterior position early in labor is undoubtedly greater than is generally believed. In certain of the pelvic variations such as the anthropoid type it is unusually high.

5. The important rôle played by the shape of the superior strait in the production of occipitoposterior position is again emphasized.

6. The importance of accurate pelvimetry in every primiparous woman is again demonstrated. The practice of scientific obstetrics presumes a knowledge of all the facts that are essential for the successful outcome of labor and the important part played by the size and shape of the bony pelvis needs no emphasis.

BIBLIOGRAPHY

1. Caldwell, W. E., and Moloy, H.C. Am. J. Obst. & Gynec., 1933, 26: 479.
2. Danforth, W. C. Ibid., 1934, 28: 756.
3. Potter, I. W. The Place of Version in Obstetrics. St. Louis, 1922, p. 127.
4. Thoms, H. Am. J. Obst. & Gynec., 1932, 24: 50.
5. Idem. Radiology, 1933, 21: 125.
6. Idem. Am. J. Obst. & Gynec., 1933, 27: 270.
7. Idem. J. Am. M. Ass., 1934, 102: 2075.
8. Turner, W. J. J. Anat. & Physiol., 1886, 20: 317.

Fig. 2. Drawing to illustrate the exposure by blunt dissection of the prevesical space, anterior surface of the prostate and membranous portion of the urethra. Distention of the bladder by the balloon and splinting of the urethra by the catheter help very much in this dissection. a, Shows the general anatomical relationships with the bladder distended and the catheter in place. b, Illustrates how the membranous urethra is opened after it has been isolated and the contained catheter is clamped and divided.

Cystectomy, a Method of Retroprostatoseminal Vesiculocystectomy.—Frank Hinman

CLINICAL SURGERY

FROM THE UNIVERSITY OF CALIFORNIA HOSPITAL

CYSTECTOMY, A METHOD OF RETROPROSTATOSEMINAL VESICULOCYSTECTOMY

FRANK HINMAN, M.D., F.A.C.S., SAN FRANCISCO, CALIFORNIA

I CAN find very few descriptions of the operation of cystectomy. The removal of an exstrophic bladder requires no particular technique. The removal of a malignant bladder, however, is a different matter. The malignant bladder should be removed intact, unopened, and with the least possible manipulation. Drainage of the pelvic space afterward is equally important, as pointed out by the late R. C. Coffey.

There are two routes by which the bladder can be removed—the perineal and the suprapubic. The perineal route is indicated in men with carcinoma of the trigone or neck of the bladder associated with involvement of the prostate, either of which may have been primary. (The vaginal route is indicated in women with cancer of the urethra and vagina.) When this involvement is extensive and the man's pelvis is "frozen with cancer," the condition probably is inoperable. Such cancers can be removed completely neither suprapubically nor perineally and radical surgery should not be attempted. In less advanced conditions, radical removal is possible. When involved, the prostate and vesicles can be freed from the rectum more easily through the perineum than suprapubically. When the prostate and vesicles are uninvolved, or only slightly so, their removal with the bladder by the method to be described is much easier through the abdomen than through the perineum. Some patients with associated vesical and prostatic involvement can be operated on to advantage by a combination of the two routes; freeing of the prostate and vesicles perineally and then enucleation of the bladder, prostate, and vesicles as one mass, suprapubically. The suprapubic route is commonly employed for cystectomy in cancer of the bladder, the usual procedure being to free the fundus of peritoneum, isolate the vesical arteries and ligate them and then peel the bladder from the vesicles and prostate.

The following method is indicated for those cases of primary cancer of the bladder which require total cystectomy and in which the urine has been diverted (uretero-intestinal implantation) in order that this might be done. In all cases of this type, even though the neck of the bladder and the prostate are not invaded apparently, the radical removal of the bladder, prostate and vesicles intact will insure more completely the removal of all the cancer. The method is retrograde as compared to the suprapubic procedure in common use and, aside from certain advantages of technique, has the additional advantage of the least possible manipulation of the bladder.

Description of the method of retrocystectomy. The bladder is washed out and left empty. A special balloon catheter (Fig. 1) is passed well up into the bladder; 200 cubic centimeters of mercurosal (or air if preferred) is injected into the balloon and the catheter is connected with tubing which is clamped off in a basin alongside the table so

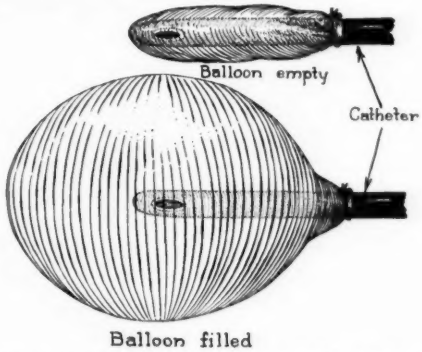

Fig. 1. Drawing of a home-made catheter-balloon. A finger cot or the finger of a surgeon's glove is tied over the end of a No. 22 or 24 soft rubber urethral catheter.

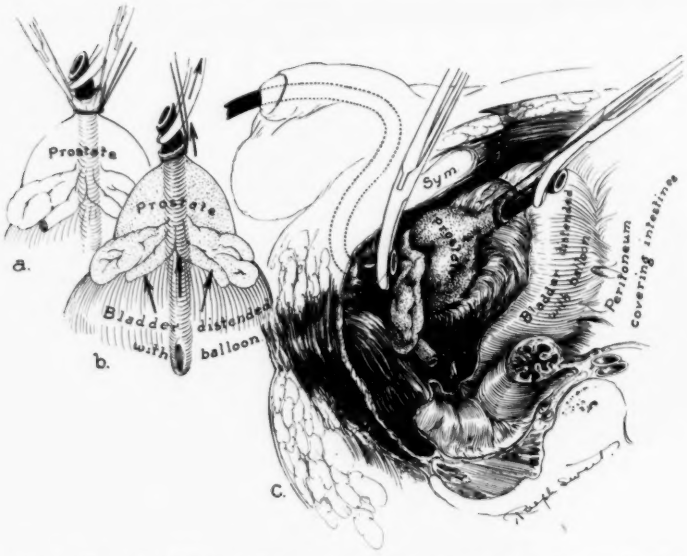

Fig. 3. Illustrates how the balloon and catheter are used for traction. a, Urethral and prostatic tissues tied to catheter by circular ligature of heavy silk. b, Shows how traction on clamp and ligature lifts the balloon and neck of the bladder. c, Shows how the prostate and vesicles can be peeled back by blunt dissection when traction is made on the catheter and balloon.

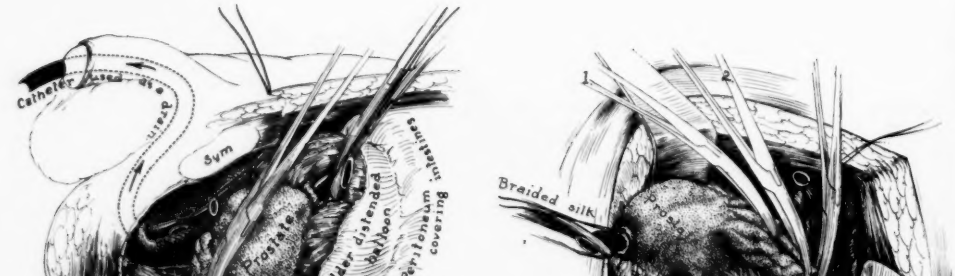

Fig. 4. Drawing which illustrates the complete freeing of the prostate and vesicles. a, View from the side: Th vas and vessels on the left side have been clamped and divided. b, View from above: The clamps (No. 2) have een placed on the vesical vessels of the right side. Clamp No. 1 is on the vas.

Fig. 5. Drawing which illustrates the bladder completely isolated except for peritoneal and urachal attachments. a, View from above showing the four clamps in place on the specimen and the corresponding partner removed after the vasa and vessels had been ligated *en masse* as shown in the depths of the field. b, Side view showing the only remaining attachment of the bladder to the urachus and neighboring peritoneum.

that a nurse can empty or fill the balloon (when the surgeon desires) and thus collapse or distend the bladder.

The suprapubic incision need not be long (4 inches). The long scar of the previous operation (ureteral implantation) is excised for about half its length. The fascia and muscles are divided in the area of the scar down to the prevesical fat. (Care is taken not to open into the peritoneal cavity.)

The space of Retzius is opened by blunt dissection with the finger, exposing the anterior surface of the prostate and bladder. The lower anterolateral wall of the bladder is freed similarly. By dissecting under the pubic arch, the apex of the prostate is localized. (There should be no bleeding.) Following the capsular surface of the prostate at the apex around each side enables one to free completely and encircle with the finger the membranous portion of the urethra. This must be done carefully, well up under the symphysis and at the apex of the prostate because the rectum may be perforated easily by the tip of a finger forced behind the prostate in the wrong line of cleavage. The catheter outlines the urethra and aids in making this dissection. When the apex of the prostate and the adjacent portion of the membranous urethra are free so that they can be encircled with the finger, the urethra (with the catheter in it) is doubly clamped and then divided (as is the catheter) between the clamps (Fig. 2).

The clamp on the distal end is replaced by a braided silk suture by which this cut end of the catheter can be pulled well into the pelvis to serve, after being perforated in a few places, as a drainage tube after the bladder has been removed. (Note discussion of this point under drainage.)

The clamp on the proximal end attached to the balloon is used for traction and in order that this purpose be fully accomplished, the urethral tissues and apex of the prostate are pulled up on the catheter by clamps on each side and anchored to the catheter by a circular ligature of heavy silk (Fig. 3, a), the ends of which are tied to the clamp on the catheter so that the two together give good traction (Fig. 3, b and c).

In the plane of separation of the fascia of Denonvillier, just as in perineal prostatectomy, the prostate can be peeled from the rectum to the area of attachment of the seminal vesicle and vas on each side. The fascial layer covering the right vesicle is incised and this vesicle is freed and delivered. The right vas and its vessels are isolated,

Fig. 6. Photograph of prostate, vesicles and bladder, with balloon-catheter in place, just as they were removed at operation intact and unopened.

doubly clamped, and divided between the clamps (Fig. 4).

The right vascular pedicle of the bladder with the ureter now is isolated by blunt finger dissection and is divided *en masse* between the clamps. The left vas and vesicle and the left vascular pedicle and ureter are clamped and divided similarly. This leaves all the blood vessels which supplied the bladder in the four clamps. The pedicle in the distal one of each pair of clamps is ligated and the clamp is removed. The proximal clamps are left on (Fig. 5).

The bladder now is attached only to the peritoneum and urachus. The former can be stripped off from below upward with moist gauze, to the point of the attachment of the urachus which is clamped and divided (Fig. 5), completely freeing the unopened bladder. In case the peritoneum is adherent to the bladder because of cancer or inflammation, an elliptical area of peritoneum around the site of adhesions can be removed with the bladder, and this opening into the peritoneal cavity can be closed without risk of contamination since the bladder has been left intact and unopened.

Drainage of the pelvic cavity, left by the removal of the prostate, vesicles and bladder, should be thorough. Otherwise an abscess may develop in a blind pocket somewhere and lead to septicæmia, as happened in one of my patients. Once the urethral catheter, which has been left for drainage (Fig. 5), has been removed, it should not be re-inserted. I am not sure that leaving this catheter in originally is not a mistake. It might be preferable to close tightly by suture the open end of the urethra and rely altogether upon suprapubic drains. A perineal drain can be placed easily and gives the advantage of dependent as well as through and through drainage. Subsequent contamination of the pelvic dead space from the urethra or by way of it is likely after the catheter has been removed. This seems to be what happened in the patient just mentioned who developed septicæmia. This man of 72 was in excellent condition for 2 weeks after cystectomy and was up and about after the eighth day. An abscess formed in the pelvis extraperitoneally about this time and he died of septicæmia 3 weeks after operation. Autopsy showed that the cancer had been radically removed. The specimen is shown in Figure 6.

TRANSPERITONEAL NEPHRECTOMY FOR MALIGNANT TUMORS OF THE KIDNEY

LAWRENCE R. WHARTON, M.D., BALTIMORE, MARYLAND
From the Department of Gynecology of the Johns Hopkins University and Hospital

WITHIN the past year or two, our attitude toward malignant renal neoplasms has changed. A new suggestion of hopefulness has been introduced. This is because we have learned that massive renal tumors can be made operable by deep roentgen-ray therapy. In our experience this applies generally both to Grawitz hypernephromata and Wilms embryomata, and these constitute the majority of renal neoplasms. We have discovered also that other tumors, of unusual and bizarre morphology, such as cystic carcinoma, may respond in a manner which makes their pre-operative irradiation worth while.

The effects of irradiation on the gross and histological characteristics of these tumors and the concomitant physical benefit to the patient have been reported by us elsewhere. Waters, Lewis and Frontz likewise have presented their experience and our clinical conclusions and recommendations coincide.

The salient point of these studies is that the operability of massive renal neoplasms has been vastly increased and the operative mortality reduced. Thus, by pre-operative irradiation, a ray-sensitive tumor which fills three-fourths of the abdomen may be so reduced that it is hardly palpable. In many instances, with the shrinking of the tumor, the hæmaturia ceases or becomes negligible. During the 3 or 4 weeks required for the course of pre-operative irradiation, moreover, we have an excellent opportunity actually to accomplish something in building up the physical condition and increasing the resistance of these patients. The disappearance of the abdominal mass and the cessation of hæmaturia makes this possible. Consequently, in many cases, by the time the course of irradiation is completed, it is found that the patient may be in fairly good physical condition and the tumor may be safely operable.

It is thus evident that we have entirely revised our pre-operative regimen since we have discovered the value of pre-operative irradiation. Now we have certain definite objects in view, and in the majority of instances, have some hope of attaining them. Whenever we are successful, a great deal of the dread and frightfulness that formerly attended the removal of big malignant renal tumors disappears. In these cases, we approach the operation with a feeling of hopefulness which was unknown two years ago.

THE OPERATION

The final result depends upon one thing—the successful removal of the tumor, for we have seen no instance in which radium or the roentgen ray has entirely eliminated a large mass. Now that we have found a means of increasing the operability of these tumors, the opportunity and responsibility of the surgeon have become even more significant. For this reason, it is imperative that we should review the operative technique of nephrectomy, to see whether it fulfills the demands of our new opportunity.

The surgical principle of the operation. In operating upon a renal tumor, we have certain very definite objectives. Perhaps we may more clearly realize their importance if we consider for a moment the general pathological characteristics of these tumors.

In the first place, they are made up of a mass of friable, malignant tissue which is in intimate contact with vascular spaces. At times, parts of the tumor actually protrude into the blood stream within a capillary or a large venous trunk. In many types, moreover, this tissue is characteristically transplantable, and if bits of it are spilled in the operative wound, they grow like weeds. These tumors are also highly vascular and often have abnormally placed blood vessels. They are frequently adherent, grow very large and have thin, delicate capsules. These are some of the factors that in the past have made the surgery of renal tumors almost a hopeless proposition. It is for these reasons that nephrectomy has so frequently been followed by a local recurrence and a shower of metastases.

On the contrary, however, these tumors have certain characteristics that make them amenable to treatment. In the first place, they seem to metastasize late, for the majority of cases show no secondary growths when they reach the surgeon. Then, again, local invasion is rather uncommon, for the tumor usually remains within its capsule even though it may fill the whole flank. Also, most of these tumors are highly sensitive to the roentgen ray and will shrink like magic if they are treated intensively. They can, moreover, be

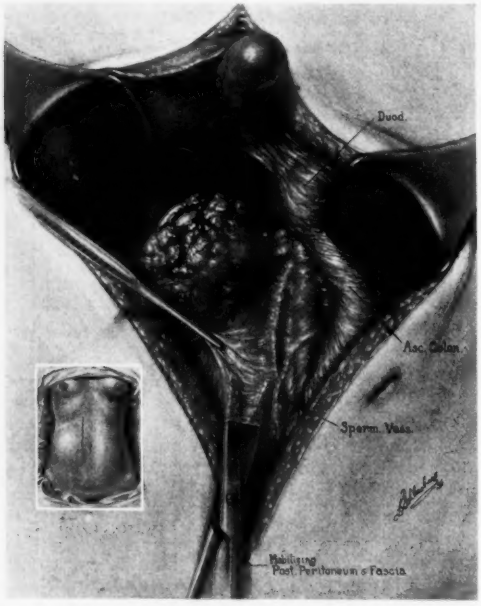

Fig. 1. The landmarks and exposure in transperitoneal nephrectomy. The illustration shows the right side, which is more complicated than the left. The abdominal incision must be large and the patient completely relaxed. The posterior peritoneum is incised at some distance from the kidney and the colon, in an avascular spot. The mobilization of the peritoneum is continued carefully until one gets an exposure like that shown in Figure 2.

recognized with accuracy by cystoscopic and urographic study. These factors are distinctly favorable, and it is only by taking full advantage of them that we have any chance whatever of removing these tumors successfully.

With this picture in mind, it is not hard to formulate an ideal nephrectomy. Such a procedure would allow us to isolate the tumor from its vascular connections before handling the friable mass. By so doing, one would avoid massaging particles of the tumor into the blood stream. This would minimize the chance of metastasis. The ideal approach would also give us such wide exposure that we could see the entire blood supply, including aberrant vessels, thus lessening the risk of hæmorrhage. Also it would furnish enough room to permit the removal of the entire mass intact without rupturing its capsule. This would tend to prevent local recurrence. How do our present methods of performing nephrectomy meet these demands?

There are two available types of operation: the lumbar or extraperitoneal, and the abdominal or transperitoneal. Of these, the lumbar is by far the most generally used, not only for renal tumors but for all operations on the kidney. Undoubtedly, we all agree that it is the rational method of attacking almost all surgical problems of the kidney because it is extraperitoneal, avoids unnecessary shock and minimizes the chance of peritonitis. But is it the method of choice in operating upon renal tumors? Does it meet the requirements which we must fulfill if we would remove these neoplasms successfully?

Clinical experience and anatomical studies indicate that lumbar nephrectomy violates every one of these principles. Lumbar nephrectomy compels one to attack the tumor before he controls its blood supply. By this approach, the mass must be widely mobilized and manipulated before the renal pedicle can be seen or ligated. Aberrant vessels are often not recognized until they bleed because they lie on the median side of the mass. The last structure to be seen and controlled is the vital renal pedicle, whereas it should be the first. The excessive manipulation required by lumbar nephrectomy has in the past resulted in the operative rupture of one-third of these tumors. This immediately makes the prognosis practically hopeless. Furthermore, in many of the extraperitoneal nephrectomies, the peritoneal cavity is opened more or less widely, although unintentionally, thus immediately cancelling one of the benefits of this particular approach. Our records of operative mortality and end-results show that, even when dealing with small tumors, lumbar nephrectomy has fallen far short of the objects we seek.

Fortunately, it is not the only procedure at our disposal. The alternate operation is transperitoneal nephrectomy.

The advantages of transperitoneal nephrectomy. These are definite. In the first place, the generous abdominal incision enables one to see the tumor clearly and to expose and ligate the renal vessels before one handles or moves the malignant mass. Aberrant vessels can be controlled because one can see the entire flank. Furthermore, the exposure allows one to remove not only the mass and the kidney intact, but also the surrounding tissues, the capsule of Gerota, the perirenal fat and areolar tissue and as much of the ureter as one wishes. In theory, therefore, the operation is based on sound principles of surgery and pathology.

Furthermore, these principles are not new or radical. They have been advocated for many years. In 1905, Walker recommended transperitoneal ligation of the renal pedicle as the first step preliminary to nephrectomy by the lumbar

route. At that time he stated that he had never seen or heard of transperitoneal nephrectomy. Nine years later, in 1914, J. M. T. Finney deliberately planned and performed transperitoneal nephrectomy for a small hypernephroma and the patient is well today. In 1921, Quinby stated that tumors of the kidney should be removed transperitoneally, although he described a surgical technique which we believe to be unnecessarily complicated and which we shall discuss later. We do not know whether he still uses that technique. Most of the recent textbooks on general surgery state without reservation that renal tumors should be removed transperitoneally.

In view of the widespread approval of the principle of transperitoneal nephrectomy, and in view of the known shortcomings of lumbar nephrectomy, there must be some very real explanation for the fact that lumbar nephrectomy continues to be the method which is most commonly used.

The chief reason is probably the question of operative technique. Although transperitoneal nephrectomy is recommended in practically all modern surgical texts, it is described in very few of them, and in none is there an illustration which would in any way help one to visualize the steps of the operation. Furthermore, the technique which is often recommended is unnecessarily complicated and presupposes an anatomical familiarity with the upper abdomen which is possessed by practically no urologists, very few gynecologists and not all general surgeons. The method often recommended involves the identification and mobilization of the duodenum, the jejunum or the ligament of Treitz, and eventually, by the use of these landmarks, the localization and ligation of the renal pedicle. Most of the renal surgery in this country is done by urologists and gynecologists, and to men in these specialties the upper abdomen is rather unfamiliar ground. Obviously, an operation thus designed could never be generally adopted. Indeed, it would be hazardous for the average gynecologist or urologist to attempt it. Realizing this unsatisfactory state of affairs, when Kelly and Burnam wrote their classic two volume text on *Diseases of the Kidneys, Ureters and Bladder* in 1915, they dismissed the whole subject of transperitoneal nephrectomy in one short paragraph, condemning the procedure unceremoniously. We hold the same opinion of the highly complicated operations that are often recommended. As we shall show, however, these technical complications are entirely needless because transperitoneal nephrectomy can be made a very simple and safe operation.

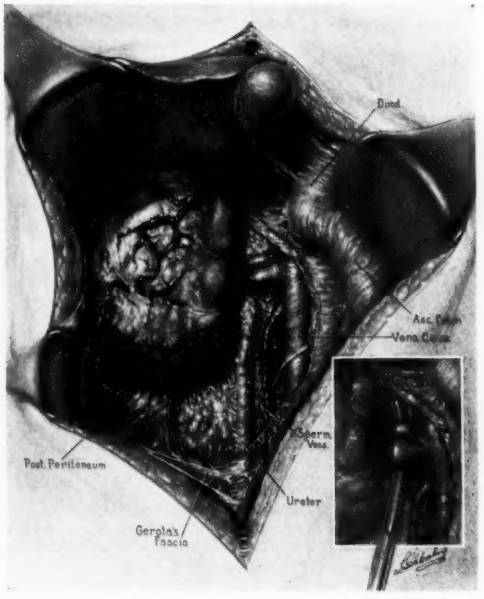

Fig. 2. The exposure of the renal pedicle. The mobilization of the peritoneum carries out of the operative field the colon and duodenum and brings one directly to the vena cava and the renal vessels. The artist does not exaggerate the clearness of the view. By this technique one obtains complete control of the blood supply of the renal neoplasm with very little manipulation. It may not be necessary to expose the vena cava. With such exposure one can devote his attention to the removal of the tumor with a wide margin of surrounding tissue; the control of the blood supply is usually a simple problem. One can also remove as much of the ureter as is necessary.

Less valid is the objection that the operation involves opening the peritoneal cavity. If, in this instance, we had the choice between two equally satisfactory operations, one extraperitoneal and the other intraperitoneal, it would certainly be good judgment to use the extraperitoneal route. But in this case the extraperitoneal approach is fundamentally faulty whereas the transperitoneal route gives us at least an opportunity to handle the surgical problem in a safe and scientific manner. The experienced surgeon would much prefer a wide transperitoneal view of a dangerous situation to a cramped extraperitoneal peep at it.

We do not underestimate the fact that a transperitoneal operation introduces factors which one need not consider when the peritoneum is not opened. We dismiss the question of peritonitis, because we do not recommend this operation for infected kidneys, except in rare situations. For the transperitoneal operation, however, the

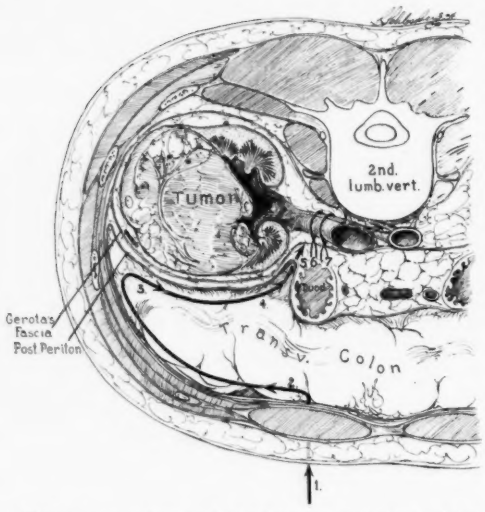

Fig. 3. A cross section of the abdomen at the level of the kidney. This shows the regional anatomy involved in transperitoneal nephrectomy. The heavy black line indicates the steps of the operation. *1*, The abdominal incision; *2*, *3*, *4*, the pushing of the large and small intestines out of the flank into the opposite half of the abdomen; *5*, the incision in the posterior peritoneum, mobilizing the duodenum and the large intestine; *6* and *7*, the ligation of the renal pedicle. The relation of the perirenal fascia (Gerota's capsule) and the posterior peritoneum is clearly shown. The drawing also explains why it is so easy to get into the peritoneum during a lumbar nephrectomy unless one opens the perirenal fascia posteriorly.

This and the following cross section of the regional anatomy of the kidney also give a clear picture of the planes of cleavage that may be followed in nephrectomy. There are three: 1, the plane external to Gerota's fascia (the perirenal fascia); 2, the plane between the perirenal fascia and the true renal capsule; 3, the true renal capsule. Usually the easiest plane is found between the true renal capsule and the layer of perirenal fascia. Obviously, when operating for malignant condition, one wants to stay as far away from the kidney as possible. We have found it easier to pick up a satisfactory plane of cleavage if one starts the dissection of the layers a few centimeters below the kidney, rather than on the kidney itself.

anæsthetic must be deeper, and the relaxation more complete, if one is to move the intestines out of the operative field easily and quickly. The opening of the peritoneal cavity probably increases the chance of pulmonary complications, as Overholt and Churchill and McNeill have shown.

Fully appreciating these facts, we nevertheless agree with those surgeons who think that the advantages of transperitoneal nephrectomy far outweigh the disadvantages, and we believe that those who will master the simple technique which we describe will be led to agree with us. Fortunately, our experience is not the only basis for recommending this method of transperitoneal nephrectomy, for, with individual variations, this general technique has been used by our surgical associates for years. We are glad to have this opportunity to express our appreciation of their suggestions and experience. Neither in principle nor in general plan, therefore, is this operation new or untried. We have found it necessary to study this subject originally because one will search the available literature in vain for a clear description of it. For the same reason, we have thought it advisable to illustrate this technique.

In many details, the operator may find it advisable to modify the method which is shown. Indeed, rarely do we ligate the renal pedicle twice in precisely the same manner, and the method of handling the ureter will vary with the situation at hand. In general, however, the method of exposing the kidney and renal pedicle is likely to be fairly constant. It will be seen that this operation presupposes no familiarity with the upper abdomen, the duodenum or the ligament of Treitz. The only intraperitoneal landmark one needs to identify is the large intestine, and thorough mobilization of the hepatic and splenic flexure moves out of the field of operation the duodenum and all adjacent retroperitoneal structures. This enables one to expose the renal vessels and also the aorta and vena cava, if one finds it necessary. We have removed some fairly large tumors by this approach and have found the operation simpler and safer than the lumbar procedure.

In presenting this study of operative technique, moreover, we are indebted not only to our surgical associates, but also to the artist and student of anatomy, Mr. Max Broedel. The accompanying illustrations were made under his guidance in his department by Mr. Leon Schlossberg, one of his pupils.

THE TECHNIQUE OF TRANSPERITONEAL NEPHRECTOMY

Step 1. The incision. We use a long rectus incision. Since we have been able to reduce the size of renal tumors by pre-operative irradiation, we have not found it necessary to make a right angle extension of this incision into the flank, although we would not hesitate to do so if we needed the additional room.

At the onset of the operation, one or two provisions are helpful. In the first place, it improves exposure to hyperextend the back as in an operation upon the gall bladder. Then, the anæsthetic must be fairly deep, if one is to push the intestines across into the opposite half of the abdomen.

One can waste a great deal of time and increase the surgical shock by trying to pack away the intestines before relaxation is complete.

Step 2. The exposure of the tumor. As the illustrations show, the operator works directly across the peritoneal cavity. The hyperextension of the back however, brings the lumbar wall nearer to the surface, and the big incision makes it entirely unnecessary to work in a hole. In fact, one should feel a distinct sense of roominess which gives one confidence and ease.

After the intestines have been pushed into the opposite half of the abdomen, one is brought immediately to the posterior abdominal wall. The large intestine is seen coursing vertically and in the renal fossa one sees the bulging caused by the kidney mass. These are the landmarks.

Step 3. The layer of posterior peritoneum is now incised. This is also a very simple step. The incision in the posterior peritoneum should be made at least 2.5 centimeters from the lateral margin of the large bowel, so that one will not injure it and have a wide flap of peritoneum for easy approximation afterward.

I find that it is much easier to incise this layer of peritoneum if one mobilizes it before cutting it. One picks up the peritoneum at a clear spot, nicks it with a knife, and then by inserting the closed scissors into this opening, mobilizes the peritoneum in the line of the desired incision. This step is illustrated.

The peritoneum is thus mobilized and cut well above the flexure of the large intestine. The large intestine is then gently pushed medially and held back by the gauze and retractors which are already in place. The peritoneum is also pushed away from the region of the renal pedicle and the kidney. The duodenum goes with the peritoneum and ascending colon. If, by chance, the kidney tumor and the peritoneum are intimately adherent, one can leave a wide patch of peritoneum on the kidney, and remove it with the tumor. When operating upon the left kidney one does not have to think of the duodenum.

The elevation of the posterior peritoneum brings one down directly to the retroperitoneal mass. The kidney is usually visible. The renal pedicle and pelvis are hidden under a layer of loose fat. In thin persons, the ureter can often be seen; it can almost always be picked up by rolling the loose areolar tissue and fat between the fingers. It can thus be exposed easily, and if traced upward will lead directly to the renal pedicle. It is often helpful to expose the ureter to the kidney at this stage, because this procedure aids in exposing and mobilizing the renal vessels.

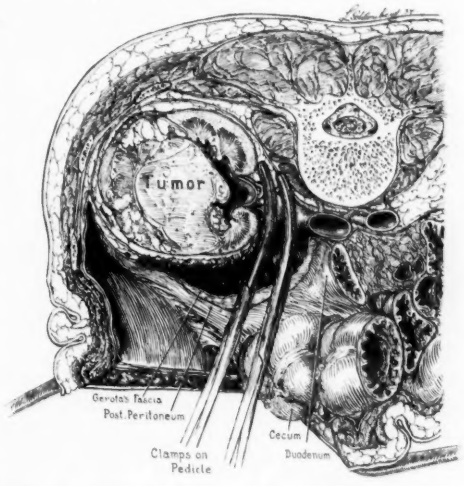

Fig. 4. A cross section view of transperitoneal nephrectomy. This shows how completely the large intestine and the duodenum are eliminated from the operative field by this technique. We make it a practice to remove Gerota's perirenal fascia with the tumor.

Step 4. Ligation of the real pendicle. This is the most important step in the whole operation. In order to expose the renal vessels clearly, it may often be advantageous to mobilize the lower pole of the kidney. This can be done gently, without moving the kidney in its retroperitoneal bed. *It is always necessary to push the peritoneum and all other structures away from the region of the renal pedicle before attempting to isolate it.* If one follows this simple rule, he will never have to fear injuring the duodenum, or any other adjacent structure. In all cases, the operator should get a clear view of the renal artery and veins; also he will often see the aorta and vena cava as well.

The renal vessels are usually buried or covered by a layer of fat. They can be located in several ways. By palpation, one can feel their pulsation. Their relation to the renal hilum usually points them out. Then, again, the ureter leads directly to the renal pelvis.

As a rule, there is no difficulty whatever in locating not only the renal vessels, but also aberrant arteries and the ovarian or spermatic vein. Before clamping and controlling the renal artery and veins, it is always wise to expose them thoroughly, removing the fat and areolar tissue by which they are concealed. They should be elevated from the bed in which they lie so that a ligature may be passed around them. This procedure is done carefully and under full vision.

Every surgeon will have his own particular method of preference in handling and isolating the renal pedicle, and he will probably vary it with changing demands.

Step 5. Removal of the tumor. It is essential that there should be no back-bleeding from the tumor or kidney at any time, as this blood will probably contain cells of the tumor. Local recurrence is very likely if this occurs.

The removal of the tumor is usually a fairly simple matter, after the blood vessels have been ligated and cut. We have not observed any unusual adhesions as the result of pre-operative irradiation. In fact, the irradiated tumors are usually harder, more compact, have a thicker capsule, and are definitely less friable and vascular than tumors which are not irradiated. We try to remove all of the perirenal tissue possible, including the perirenal fat, Gerota's capsule (the perirenal fascia), a long strip of the ureter and all the areolar tissue we can safely take away.

Step 6. Closure. The posterior layer of peritoneum is closed tight by a continuous suture of plain catgut. If drainage is necessary, it can be provided through a stab wound, extraperitoneally, in the flank. We did not drain our last two transperitoneal nephrectomies, and the wounds healed cleanly.

The operation which we have described is usually done very easily in a little more than 1 hour, requires no pulling or tugging, entails very little shock, and in our opinion, is much less risky than a lumbar nephrectomy for tumor.

CONCLUSIONS

We have described and illustrated the steps of a simple method of performing transperitoneal nephrectomy. We present this because of the current opinion that transperitoneal nephrectomy is a dangerous and complicated operation and because this particular technique has not been illustrated in the available literature. It is our opinion and the opinion of many other surgeons that transperitoneal nephrectomy is far safer than lumbar nephrectomy for the removal of renal tumors.

We present this as part of a study of renal tumors. In another communication we outlined our experience with the pre-operative irradiation of malignant renal tumors. We have found that pre-operative irradiation makes many of these big tumors operable by reducing their size remarkably. It has also been our experience that in transperitoneal nephrectomy we have a surgical technique which gives us a chance to remove these tumors with fair safety and with a minimum likelihood of rupturing the mass. We cannot venture an opinion as to the effect this method of treatment will have on the number of permanent cures. We do know, however, that the first step is the successful removal of the tumor and in this communication we have outlined two procedures which have helped us to accomplish this step.

BIBLIOGRAPHY

1. CHURCHILL, EDWARD D., and MCNEILL, DONALD. The reduction in vital capacity following operation. Surg., Gynec. & Obst., 1927, 44: 483–488.
2. FINNEY, J. M. T. Personal communication.
3. KELLY, HOWARD A., and BURNAM, CURTIS F. Diseases of the Kidneys, Ureters, and Bladder. Vol. 1, p. 384. New York: D. Appleton & Co., 1914.
4. OVERHOLT, RICHARD. Air in the peritoneal cavity; its effect on the position and activity of the diaphragm. Arch. Surg., 1930, 21: 1282–1290.
5. QUINBY, WM. C. The transperitoneal approach to the kidney; its indications and limitations. J. Urol., 1921, 5: 135–147.
6. WALKER, GEORGE. Transperitoneal ligation of the renal vessels. J. Am. M. Ass., 1905, 45: 1647.
7. WATERS, CHARLES A., LEWIS, L. G., and FRONTZ, W. A. Radiation therapy of renal cortical neoplasms with especial reference to pre-operative irradiation. South. M. J., 1934, 27: 290–299.
8. WHARTON, LAWRENCE R. The pre-operative irradiation of massive tumors of the kidney. A clinical and pathological study. Arch. Surg., 1935, 30: 35-51.

LYMPHANGIOMATA OF THE GREAT OMENTUM[1]

ALBERT H. MONTGOMERY, M.D., AND IRVING J. WOLMAN, M.D., CHICAGO, ILLINOIS

ABDOMINAL tumors are not common in children. The most frequent and generally recognized types at this age are neoplasms involving the kidney and ovary. Among the rarer forms are the lymphangiomata of the great omentum. These tumors occur very infrequently and the cases are somewhat of a surgical and pathological curiosity. Sporadic isolated case reports appear from time to time. Stillman reported 2 cases in 1911, and included in his paper summaries of 19 other cases which had been published up to date. We have verified his sources and reviewed the literature since 1911, with reference to 2 cases recently observed at the Children's Memorial Hospital, and have found reports of 30 other cases, including 5 reported before 1911 which were omitted from Stillman's group. The total number of cases, including our own, is 53, a group which is sufficiently large to permit some statistical discussion with a view toward outlining the significant features of the general disease picture.

Our interest in this subject was stimulated by 2 patients who came under our observation with the following case histories:

CASE 1. L. K., a Polish girl, 5 years of age, entered the Children's Memorial Hospital, April 7, 1931. About 2 years previous, the mother had noted that the child's abdomen was gradually becoming larger. During the next 4 months the child seemed rather listless at home, played very little and had a poor appetite, but did not complain of any pain. The abdominal swelling seemed to fluctuate a little in size during this period. For the next 16 months up to the time of admission, the child's condition had been rather stationary with no change in the size of the abdominal tumor or in the listless appearance of the child. However, about 5 weeks before her entrance into the hospital she began to complain of abdominal pain occurring mostly at night and causing her to cry out. There was no nausea during this period, but her mother thought that occasionally the child showed a small amount of fever.

During the two previous years she had had chicken-pox, whooping cough, and measles without complications. Her history otherwise was negative.

The findings on physical examination showed nothing abnormal except the abdomen which was quite prominent and had a doughy resistance but seemed to be tympanitic throughout. In the right lower quadrant in the region of McBurney's point a discrete, movable mass about the size of an egg could be palpated. It was not tender and could be moved around for a distance of about 2 inches. The mass felt distinctly like a cystic tumor.

An examination of the urine showed nothing abnormal, and a tuberculin skin test was negative. An examination of the blood showed hæmoglobin of 55 per cent, red blood cells 3,360,000, and white cells 11,400 of which 50 per cent were polymorphonuclear leucocytes and 48 per cent lymphocytes.

During her period of observation the child developed scarlet fever complicated by the finding of diphtheria organisms in her throat during convalescence. It was necessary to remove the child's tonsils before a negative throat culture could be obtained. After that the child seemed to be in good condition so it was decided to investigate the tumor mass in the abdomen by means of an exploratory laparotomy.

Operation. July 18, 1931, under ether anæsthesia the abdomen was opened by a midline incision. It was found that the mass that had been palpated before operation, was attached to and part of a large cystic tumor which occupied most of the great omentum. The mass was easily delivered from the abdomen except for the part which was attached to the transverse colon near the splenic flexure by a broad pedicle. This was severed as close as possible to the colon and the tumor removed. For fear of interfering with the blood supply of the colon, a few small cysts were left in the pedicle when it was ligated. The abdomen was closed and the child went on to an uneventful recovery. She was discharged from the hospital in good condition on August 2, 1931.

Pathological examination. Report by Dr. Irving J. Wolman (Fig. 1). The specimen is a large irregular tumor mass weighing about 1,500 grams and measuring 30 by 20 by 8 centimeters when completely spread out. It consists of numerous confluent rounded cysts situated within the substance of the great omentum. The cysts vary in size from being just visible up to 13 by 9 by 6 centimeters which is the measurement of the largest. The cysts have rounded contour and many are spherical, others seem to have anastomosed and their shape is more irregular. There are numerous constrictions and grooves on their surfaces. Sometimes they seem to anastomose with each other through a cluster of smaller intermediate lying cysts. Their wall is thin and pale, often membranous, and shows dilated, narrow, widely separated blood vessels within it. The outer surface has a smooth, serous appearance. Strands of delicate omental fatty areolar tissue run among the nodules binding them together. The cyst content consists of colorless or gray, semi-solid, jelly-like fluid. It varies in consistency and opacity in the various chambers. After preservation in formaldehyde, these contents assume a white, coagulated appearance. In several cysts, the capsule is thick, white, and hyaline, measuring as much as 2 millimeters in thickness. The lining is pale and smooth, but there are patches of coarse, wrinkling, and elevated trabeculations. No blood or large cellular masses are noted within the cysts. They extend all through the omentum, some being present at the cut edge. The gross appearance is that of a cystic lymphangioma of the omentum.

Histological note (Fig. 2). Five sections were examined. The cyst contents stain a homogeneous pale granular matter. Their walls are formed of hyaline, relatively acellular, fibrous tissue in the form of a capsule. The wall of some cysts is more compact and thicker than others. Occasional small round cells occurring singly or in small groups are noted within the interstices, and also some large mononuclear cells with basophilic homogeneous cytoplasm and eccentric hyperchromatic nuclei. There is no

[1]From the Surgical Service of the Children's Memorial Hospital, and the Department of Surgery, Rush Medical College of the University of Chicago. Read before the Chicago Surgical Society, May 4, 1934.

Fig 1. Multilocular cystic lymphangioma of the great omentum.

definite endothelial or epithelial lining to the large cysts, and their contents appear to be in direct contact with the innermost layer of the fibrous tissue wall. There are a few foci of flattened clusters of large vacuolated phagocytic cells. These groups occur on the inner surface of the cyst wall, lying partly within the fluid and partly infiltrating the contiguous interstice of the fibrous capsule. These cells have no definite formation. A basement membrane is not evident. The smaller cysts have a definite lining of a single layer of flat endothelial cells. Within the walls of the cyst, one notes in many places large clusters of small round cells, apparently lymphocytes, situated within the tissue interstices in the neighborhood of blood vessels. There are many small thin walled dilated engorged vessels to be seen. A small number of dilated, but otherwise normal appearing, lymphatic channels are noted among the cysts. Narrow bundles of smooth muscle cells are occasionally seen. The omental flap has a normal structure. Its vessels are all dilated, engorged, and the walls seem a little hypertrophied. Occasional small clumps of plasma cells lie in conjunction with these. There is no cellular evidence of a pyogenic or malignant process in these sections. The microscopic findings are those of a lymphangioma of the cavernous type.

Diagnosis: Multilocular cystic lymphangioma of the great omentum.

Case 2. A white boy, 18 months old, was brought to Dr. Edwin P. Russell because his mother noticed that he had become pale and refused solid food 2 days before. Dr. Russell found that his temperature was 100.6 degrees, his red blood cells 2,600,000 and his hæmoglobin 55 per cent. Three days later when he saw the patient again the child seemed weaker and there was some rigidity of the muscles on the right side of the abdomen. No tumor mass could be felt, but the right side of the abdomen was flat and the left side was tympanitic. He gained the impression that there was fluid in the peritoneal cavity, but that it was mainly on the right side. The blood count at this time was 2,300,000 red blood cells. An abdominal tap was made and 10 cubic centimeters of bloody fluid with a red blood cell count of 2,600,000, and containing degenerated red cells, was withdrawn. It was noted that the red cell count of this fluid and the blood were the same. After a few days the child's red blood count dropped to 1,900,000 and he vomited after taking solid food.

With this history he was sent to the Children's Memorial Hospital November 22, 1932, where he was seen by Dr. Brennemann and Dr. Montgomery. Although no history of a fall or any recent injury could be obtained, a probable diagnosis of a tear of the liver or spleen was made, because of the bloody fluid in the abdomen. Conservative treatment was instituted, and after 10 days his blood count had risen to 3,000,000 and his hæmoglobin to 41 per cent. He was sent home but returned 6 weeks later because 3 days previous his temperature had risen to 103 degrees and his abdomen had become more distended. For 2 weeks also he had complained of dull abdominal pain. The child was still anæmic and showed the same signs of abdominal fluid. He was again placed on conservative treatment and the anæmia improved but the distention gradually increased until the abdomen became very tense. Because the child ran a low grade fever and developed a cough, although nothing definite could be found on examination of the lungs, conservative treatment was continued. After 4 weeks the child had become so dyspnœic from the extreme abdominal distention, that relief by surgical treatment was deemed advisable.

Operation. February 18, 1933, under ether anæsthesia the abdomen was opened by a right paramedian incision. As soon as the peritoneum was incised bloody serous fluid poured out and 1,500 cubic centimeters was aspirated, and about 500 cubic centimeters was lost. It was then evident that the fluid had come from a large thin walled cyst which was adherent to the peritoneum of the abdominal wall. The cyst was dissected from these adhesions and was found to be in the right side of the abdomen and attached by a broad base to the transverse colon. The pedicle was clamped and cut as close to the colon as possible and the cyst completely removed. Convalescence was uneventful and the child was discharged in good condition 2 weeks later.

Pathological examination. Report by Dr. W. G. Hibbs (Fig. 3). The gross specimen is a huge, oval cyst with a fluid capacity of 1,500 cubic centimeters. Outside, its surface is gray to pink and streaked generously with blood vessels. The cyst wall is uniformly 10 to 15 millimeters thick throughout except at the surgically amputated stump which is 3 centimeters in diameter. Grossly the wall is rigid. The sac content consists of dark red to brown serum, loose and firmly clotted blood, much of which is easily shredded fibrin.

Histologically, the cyst wall is essentially dense fibrous tissue which is moderately vascular. Isolated, distended lymph vessels are present. There is a moderate perivascular infiltration of leucocytes. The lining of the cyst wall consists of flat, long endothelial cells generally two cells thick. Where clotted blood is attached to the wall of the sac there is a dense hyperplasia of endothelial cells and fibroblasts which ramify together and extend up into the clotted blood. It is here that deposits of hæmosiderin are present.

Diagnosis: Unilocular cystic lymphangioma of the great omentum.

In the omentum, lymph cysts or lymphatic cysts or lymphangiomata appear as localized collections of serous or chylous fluid arising within the omental tissue and possessing a definite lining membrane. They may be single or multiple, and their behavior is benign.

There has been a great deal of discussion as to their manner of origin. Outerbridge, and Girvin and Speese, whose patients presented chains of

grapelike cysts along the omental margins in association with fibrous pelvic adhesions involving the omentum, explained the condition by suggesting that mechanical pressure, with secondary fibrosis, closed the perivascular lymph channels, with resulting stasis and varicose distention. These closed chambers grow and eventually attain a large size. In their walls a number of associated, small, dilated lymphatic vessels can be found. Fisher thought that the primary lesion in his case was fibrosis of the omentum produced by hæmatogenous invasion by microorganisms from infected tonsils.

The theory of occlusion and stasis as the source of lymphangiomata, was first suggested by Rokotansky, who thought that perhaps infarcted dried chyle masses produced the cystic dilatations. In defense of this point of view, it has been repeatedly pointed out that in various diseases, such as filariasis and metastatic cancer, obstruction to major lymphatic trunks will occasionally produce lymphaniectasia.

However, in view of the numerous anastomoses existing in the lymphatic system, and the failure in most instances to demonstrate any significant anatomicopathological change which might give rise to lymph retention, this mechanical theory of an occlusion and stasis cannot be considered entirely acceptable. The recent studies on elephantiasis by Reichert, Matas, and Homans and Zollinger, demonstrate that for the production of chronic lymph stasis, infection of the tissues or veins, in addition to mechanical obstruction, is essential. It might be further pointed out that lymph stasis due to obstruction is ordinarily accompanied by local œdema of the surrounding tissues. Moreover, involvement of the omentum in pelvic inflammatory disease ordinarily produces neither cystic dilatation or lymphœdema; the simultaneous occurrence of chronic pelvis adhesions with omental cysts must be regarded as purely fortuitous. The fibrosis and lymphocytic infiltration of the interstitial tissue which accompany lymphatic cysts, can be equally well attributed to a cellular response to the mechanical stress and strain of the weighty structures.

In regard to local conditions in the omentum, although the anatomy of the main lymphatic trunks has apparently never been carefully studied, there exists an extensive surface for the development of collateral circulation in case any of the trunks become occluded. Any obstructive process which obstructed all channels would of necessity be easily recognizable.

To quote Ribbert[1]: "The growth of a lymphangioma does not depend on a primary increase of contents with secondary stretching of the wall, but fundamentally on a growth process in which the lining cells and the fluid contents increase simultaneously."

[1]Geschwueltslehre, 1914, p. 226.

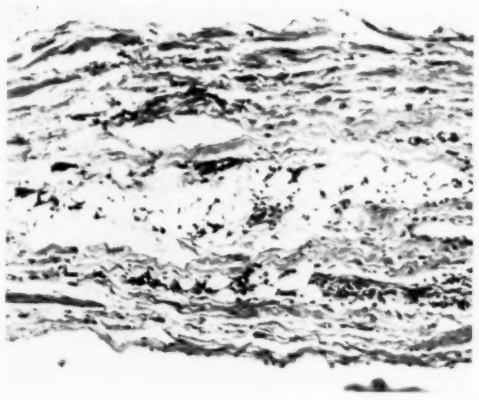

Fig. 2. Photomicrograph of supporting trabecula lying between two large cystic chambers. The flat endothelial linings are evident in some areas. There is connective proliferation and some round cell infiltration of the trabecular stroma. Some dilated channels are also present.

The consensus among contemporary pathologists is that these are true neoplastic growths developing by proliferation of the cellular elements of their wall, accompanied by secretion of the cyst contents.

The term "cyst" refers to a localized collection of fluid within a limiting membrane, without definite reference to the pathological nature. A more proper term would be "cystoma" indicating a cystic new-growth. They are identical in structure with the cystic lymphangiomata which are found elsewhere in all parts of the body. The morphology seems sufficient proof that they arise from lymph vessels rather than from epithelial embryonic nests, misplaced peritoneal inclusions, blood vessels, or degenerated lymph nodes, as have been suggested by various authors.

The distinction between unilocular and multilocular cysts, both of which may occur in the omentum, seems to be of little fundamental significance. Both types possess identical fibromuscular walls, lined with a single layer of endothelium, and contain either colorless or chylous fluid unless secondary hæmorrhage has occurred. Some of the unilocular cysts possess incomplete septa which partly divide them.

These tumors may occur at any age as can be seen in Table I.

Fig. 3. Unilocular cystic lymphangioma of the great omentum.

TABLE I.—AGE OF PATIENTS AT ONSET OF SYMPTOMS

	Cases
Infancy	11
1 to 5 years	18
6 to 10 years	5
"Child"	1
10–20	5
21–30	5
31–40	2
41–50	3
51–60	0
"Adult"	3
Patients under 11 years	35
Patients over 11 years	18

It is noticeable that 35, or approximately 66 per cent, of the cases were in children under 11 years of age. In regard to the character of the lymphangiomata, 25 were unilocular, 25 multilocular, and in only 3 cases were multiple tumors present.

The cyst in most cases rested entirely free in the abdominal cavity except for the pedicle attachment. In 15 cases adhesions were found between the cyst and other structures; in 6 instances to the abdominal wall; in 6 to the uterus; and in 1 to the intestine, pancreas, and inguinal canal, respectively. The tumors graded in size from the very smallest to cysts that were recorded as containing 16 quarts or weighing from 40 to 60 pounds.

The most frequent pathological complication was twisting of the pedicle of the cyst that occurred in 6 cases. Rupture of the cyst occurred in 1 case and hæmorrhage into the cyst in another.

The clinical features associated with these lymphangiomata are not characteristic. Symptoms are usually slow in developing and are of long duration, the average time being 2.3 years. In a general way these cases may be grouped clinically as shown in Table II.

TABLE II.—CLINICAL FEATURES OF LYMPHANGIOMATA OF THE GREAT OMENTUM

	Cases
Group 1—Symptoms due to the size of the tumor	42
A—Diffuse abdominal swelling	31
B—Localized palpable mass	9
C—Abdominal pain and distress	11
Group 2—Symptoms produced by twisting of pedicle or rupture of cyst. Clinical picture closely simulates that of appendicitis or twist of pedicle of an ovarian cyst	6
Group 3—No symptoms—Cyst discovered incidentally during abdominal operation	5

1. In the first group symptoms are due to the size of the tumor. A very large majority of the cases in this series, 42 of 53, were in this group. The most frequent clinical finding in these patients was a diffuse abdominal swelling which was present in 31. The swelling in many instances showed signs of fluid which appeared to be cystic in some cases, but was regarded as ascitic in others. The principal symptoms associated with the abdominal swellings, when they become large, were general weakness which was evident in 5 patients, dyspnœa on exercise which was exhibited by 6 patients, and loss of weight which occurred in 4 patients.

Instead of a diffuse abdominal swelling a palpable local lump was present in 9 cases. In our first case, the size of the palpable mass gave a very erroneous idea of the actual size of the cystic mass. Sensory symptoms were noticeably absent in most cases in this group, but abdominal pain and distress were described by 11 patients. The pain was usually of a dull character and was present at irregular periods. Loss of appetite with or without nausea and vomiting was not infrequent.

2. The second group, in which the symptoms were produced by a twisting of the pedicle of the cyst consisted of only 6 cases. In contrast to the larger previous group, the clinical features were all indicative of an acute abdominal inflammation, resembling appendicitis, or the torsion of the pedicle of an ovarian cyst.

The clinical picture usually began with abdominal pain associated with nausea and vomiting. Abdominal tenderness, and sometimes rigidity, with moderate fever and leucocytosis were present. In one of the cases of this group the symptoms were due to a traumatic rupture of the cyst.

3. The third group was made up of 5 cases in which there were no symptoms and the cysts were discovered incidentally during operation for other abdominal conditions, usually uterine myoma a.

The indefinite and meager clinical features and the rarity of these omental cysts tend to make the diagnosis somewhat difficult. It is not strange, therefore, that in this group of 53 cases the correct preoperative diagnosis was made in only 1 instance. A diagnostic abdominal puncture was made in 13 cases, but it did not seem to be of much assistance. It was employed in our second case and the finding of bloody fluid only served to obscure the diagnosis. The fact that 66 per cent of the cases reported have been in the age of childhood should be emphasized, as well as the comparatively symptomless character of the slow growing abdominal mass.

Tuberculous peritonitis will often be confusing unless it can be ruled out by a negative tuberculin reaction. Ovarian cysts which are not confined to the pelvis will be hard to differentiate. Mesenteric cysts, uterine myomata, and congenital cysts of the liver will have to be considered. The cases with acute symptoms due to a twisted pedicle simulate appendicitis or torsion of an ovarian cyst so closely that differentiation will probably be impossible.

Surgical treatment was employed in all of the cases in this series except the first one on record which was reported in 1851 by Gairdner, who found an omental cyst at autopsy. Aside from the fact that some of the patients are very young, the operative procedure is relatively simple. The cyst is exposed, freed from adhesions, and removed in the same manner as an ovarian cyst.

The surgical results in general were very satisfactory. Omental cysts are benign tumors and do not tend to recur after removal. The operative mortality in this series was very low as there were only 2 deaths in the 53 cases.

SUMMARY OF CASES COLLECTED FROM THE LITERATURE

In 1911, Stillman reported 2 cases of true lymphatic cysts of the omentum and collected 19 others from the literature. These included the unilocular solitary type of cyst as well as the multilocular lymphangiomata, and were reported by Gairdner (1851), Gooding (1887), Spencer Wells (1890), Erdheim (1896), Marfan (1896), Hearn (1897), Braithwaite (1898), Jacobi (1901), Marsh and Monsarratt (1901), Schramm (1903), Boyd (1903), Schwarzenberger (1894), Young (1905), Matthews (1905), Fort (1907), Wakefield (1907), Rodman (1909), Seefisch (1909), and Gifford (1910). Details concerning the above tumors are readily available in Stillman's comprehensive article. We have reviewed the more recent literature to supplement the above list, and we have found reports of 30 more cases, not including the 2 cases of our own. The 30 cases abstracted are as follows:

CASE 22. Reported by Brandt. Patient was 15 years of age; sex not stated. The patient had a freely movable abdominal tumor reaching to the navel, and the diagnosis of omental cyst was made. Operation disclosed a large, single cyst containing 2 liters of dark fluid. The wall was not lined with endothelium. Recovery was uneventful.

CASE 23. Reported by Dewitsky and Morosow. In a male, 2 years of age, an abdominal swelling was noted in the first year of life. Physical examination showed an enlarged abdomen with circumference at navel of 64 centimeters and a fluid wave and dulness to percussion. There had been an intermittent diarrhœa since 1 month of age. The clinical diagnosis of tuberculous peritonitis was made. Operation exposed a large abdominal cyst containing 4 liters of chocolate colored fluid which was evacuated. Repair of a congenital inguinal hernia was also done. Death occurred the next day. At autopsy the large cyst and numerous smaller cysts were found to have an endothelial lining; the omental lymphatics were dilated.

CASE 24. Reported by Da Costa. A thin walled uniocular cyst containing dark colored fluid and having a fibrous lining was removed from a male child.

CASE 25. Reported by E. M. Hasbrouck. The patient, 50 years of age, colored, had an abdominal swelling which had begun 1 year previously, and gradually increased until the abdomen became enormous. Dyspnœa, constipation, and frequent micturition resulted. At operation a large, thick walled cyst containing a blood clot, and with many small cysts in its wall, was found. This was estimated to weigh about 40 pounds. It was situated in the omentum between the stomach and transverse colon. Microscopically the cells appeared "epithelium-like in structure, with a disposition to arrange themselves in columns encircling the blood vessels." Hasbrouck considered the specimen to be an endothelioma. However, it was later restudied in the laboratory of Dr. J. C. Bloodgood (according to McDonald) and was there considered a benign lymphogenous cyst.

CASE 26. Reported by N. M. Kakuschkin. The patient, a female, 28 years of age, had a history of gonorrhœa. An abdominal tumor had been noted for 5 months. A preoperative diagnosis of omental or ovarian cyst was made. Operation showed many small cysts in the omentum, which was bound to the internal genitalia by numerous fibrous adhesions. These cysts were lined with flat mesothelial cells, which occasionally assumed a cuboidal appearance. Evidences of hæmorrhage were found in a few of the chambers.

CASE 27. Reported by Markoe and McPherson. Female adult. In the course of a hospital stay for purposes of confinement, an easily movable, painless tumor was palpated just above the fundus of the uterus, between the ensiform cartilage and umbilicus. After delivery a second tender, fixed mass was palpated in the left broad ligament region. At operation two separate and distinct cysts were removed from the omentum. The larger, the size of a grapefruit, lay in the right side of the pelvis, displacing and adherent to the uterus. The other, the size of an orange, was adherent to the appendix. The cysts were filled with serous fluid, had smooth fibrous walls, and were subdivided by connective tissue septa. No endothelial or epithelial lining was recognizable. Certain areas had undergone calcareous degeneration.

CASE 28. Reported by Markoe and McPherson. Female, 27 years of age. A tumor in the right inguinal region had

been present since birth. This was found to be the size of a grapefruit, slightly fluctuant, and gave no impulse on coughing. It was thought to be an inguinal hernia. On cutting down over the mass the operator found it to be a thin walled omental cyst which had prolapsed through the inguinal canal and was attached by a long pedicle. Through an abdominal incision the pedicle was tied off and the cyst was easily removed by way of the inguinal incision. Recovery was uneventful. The cyst wall was found composed of connective tissue principally with some round cell infiltration indicating acute inflammation.

CASE 29. Reported by Frank. Female, 20 years of age. The patient had been wearing a pessary for 10 months because of uterine prolapse. Seven months ago she noticed an enlargement in the pelvis which had been gradually increasing in size. Her bowels were constipated. On examination a cystic abdominal tumor was palpable in the region of the navel, and there was a protrusion of the abdomen about the size of two fists. *Per vaginam* a number of cystic nodules could be felt, filling up the entire pelvis. A diagnosis of ovarian cystomata was made.

At operation a large multilocular cystic formation of the omentum was removed. In addition, numerous small similar cysts were scattered on all the peritoneal surfaces, the cæcum, small gut, mesentery, uterus, broad ligament, tubes, and ovaries. Each cyst was easily separated from its neighbor and from its attachments. Their walls were thin and they contained clear serum. A rather large cyst was found in the groin fascia, external to the external inguinal ring. All the cysts had an identical microscopic appearance, and were lymphangiomatous in character.

CASE 30. Reported by Funk. Female, aged 17 years. An abdominal swelling was first noted 3 years earlier. The abdomen became the size of a 9 months' pregnancy and produced symptoms on pressure. Operation showed a single, large cyst within the substance of the omentum, which was drained and then dissected. Its wall was thin, regular in thickness, and consisted of fibrous tissue. Internal to this capsule was a single row of flat cells. Recovery was uneventful.

CASE 31. Reported by Outerbridge. Female, 34 years of age, had a large uterine myoma, with many adhesions in pelvis. There were numerous endothelium lined, numerous small grape-like cysts filled with clear fluid at omental margin, with a string of smaller ones running down the center. There was a continuous gradation from the simple dilated lymphatic channels to the largest cyst. The author believed that the peri-uterine adhesions blocked the lymphatic circulation and thus produced this lymphangiomatous dilatation.

CASE 32. Reported by Kenney and Mason. Female, 30 years of age, had had abdominal discomfort for 6 years and swelling for 2 years. No pre-operative diagnosis was made. A large multilocular cystic lymphangioma of the omentum was found. Some adhesions to the parietal peritoneum were present.

CASE 33. Reported by Bloodgood. Female, aged 2 years. This infant had had swelling of the abdomen for 21 months. An exploratory operation was done and a cyst in the lesser peritoneal cavity was opened and drained. The patient recovered and was well 1 year later.

CASE 34. Reported by Bloodgood. Male, aged 3 years. There had been intermittent attacks of abdominal pain for 18 months, with nausea and vomiting. Swelling of the abdomen, resembling ascites, was also present increasing rapidly during the last 6 weeks. Aspiration yielded 12 quarts of reddish fluid. At operation a large multilocular single cyst was found and removed. Twelve days later a second operation had to be done because the ligated omental stump had become gangrenous.

CASE 35. Reported by Bloodgood. A child, 4 years of age, had a large, single lymph cyst measuring 27 by 20 by 10 centimeters removed from the omentum. In its wall other minute cysts were found. The child was well 1 year later. No clinical data is given.

CASE 36. Reported by Pylbus. Female, 4 years of age. The abdomen was swollen since 9 months of age. It was tapped when she was 18 months, 2 years, and 4 years of age. Slightly red fluid, containing cholesterin crystals was obtained. Operation showed a thin walled cyst occupying larger part of abdomen. It was partially loculated and situated in the greater omentum, from which it was readily stripped. The upper part peeled from greater curvature of stomach. The omentum was repaired after removal, completing the anterior wall of the lesser sac. Recovery was satisfactory and the child was discharged in 2 weeks. The cyst was the size of a large soccer ball. Microscopic examination showed no epithelial lining to its wall.

CASE 37. Reported by Speese. Male, 5 years of age had a sudden abdominal pain 24 hours before admission. There had been no previous symptoms. The abdomen was found distended with some tenderness and rigidity over appendiceal region. The white blood count was 20,000 with 80 per cent polymorphonuclear cells. A diagnosis of acute appendicitis was made. At operation an omental cyst containing 36 cubic centimeters of amber fluid with pedicle twisted was found in the upper right abdominal quadrant. The cyst was removed. Death from acidosis occurred the next day. At autopsy numerous small clear cysts were found in the gastrocolic and greater omentum. The cyst walls were lined with endothelium. Some of the omental lymphatics were dilated.

CASE 38. Reported by Halsted. Female, 2 years of age. The child had a swollen abdomen and the diagnosis of ascites was made. When a small incision for drainage of the abdomen was made, the delicate cyst wall presented itself and commenced to herniate. On further exploration a large thin walled hygroma and several smaller ones were discovered in the greater omentum, and posterior mesogastrium. These were opened and drained. When the patient was seen at 24 years of age, she was normal, and there was no suggestion of an abdominal tumor.

CASE 39. Reported by Borschers. Male, 4 years of age. Abdominal enlargement had been present since May, 1918; no other symptoms. Operation was advised when the patient was first seen in October, 1918, and refused. When brought back February, 1919, the child had an enormous abdomen hanging like a bag. He had to sit with legs wide apart to make room for belly. The abdominal circumference was 74 centimeters or 34 inches. Abdominal puncture yielded a small amount of brownish, albuminous liquid. The physical examination otherwise was negative, and the von Pirquet test was negative. The diagnosis of "ascites of unknown origin" or "cystic tumor" was made. At operation a multilocular omental tumor was easily removed. Convalescence was uneventful and the child was well when seen 2 months later. The entire omentum was filled with cysts of all sizes, up to an infant's head. These were supported by thick, fibrous, trabeculated septa, many intercommunications. They contained brownish alkaline albuminous fluid, which formed a sediment of fatty cells, lymphocytes, cholesterin crystals, and debris. The walls were made of dense, nuclear connective tissue, in which were many thin-walled dilated vessels. Some of the cavities were lined with endothelium. There were many lymphocytes in the supporting stroma and a loose network of smooth muscle fibers.

CASE 40. Reported by Girvin. Female, 39 years of age. The patient was operated on for a uterine fibroid, which was found to have a twisted pedicle attached to and sur-

ished by the omentum. They found many lymphaniectatic cysts on the right side of the omentum and ascribed the cysts to blocking of the lymphatics.

CASE 41. Reported by Arzela. Female, 3 years of age. Gradual swelling of the abdomen began at 1 year of age. She was brought to the hospital for frequency of urination of 3 days' duration. The abdomen was uniformly enlarged, smooth, fluctuant, and dull to percussion. The diagnosis of omental or mesenteric cysts was made. At operation a pedunculated cyst measuring 17 by 26 centimeters was discovered arising by a pedicle from the central region of the greater omentum. It was removed without difficulty and the child made an uneventful recovery. The tumor had a thin, transparent wall and contained clear, lemon colored watery fluid. It was lined by flattened mesothelial cells. Many blood and lymph capillaries and clumps of lymphocytes were found in the wall, but no other cysts. The author attributed the cystic formation to an anomalous development of a lymph node.

CASE 42. Reported by Bernadet. Male, 24 years of age. The patient had had an abdominal tumor for 5 months, which suddenly became painful and caused vomiting. At operation a cyst the size of an apple, with twisted pedicle, was found. The specimen was not described further.

CASE 43. Reported by Lawrence. Female, 3 years of age. The abdomen had been prominent since birth. There had been frequent attacks of abdominal pain for 6 months, relieved by cathartics 24 hours before admission to the hospital. She was taken ill with severe abdominal cramps. There was no vomiting, and enemas gave no relief. When examined, she appeared prostrated, with a distended abdomen which was tense, smooth, dull to percussion, and cyanotic in color. There was a leucocytosis of 12,000 cells, with 82 per cent polynuclears. At operation a large omental cyst with a twisted pedicle was found and removed. Convalescence was satisfactory. The cyst had several large communicating compartments, and was lined with endothelium.

CASE 44. Reported by Ladd. Female, 8 years of age. She had had for 3 months a distended abdomen which was flat to percussion and presented a fluid wave. Examination was otherwise negative except for undernutrition. Exploratory puncture yielded a brownish cloudy fluid containing broken down red cells. At operation a large, thin walled cyst was removed from the great omentum, close to the transverse colon. This contained over 1,000 cubic centimeters of fluid. Microscopic examination showed the wall to be composed of alternate layers of smooth muscle and connective tissue. It was quite vascular and aggregations of lymphoid cells were seen about the blood vessels. The pathological diagnosis was omental cyst of lymphatic origin. Convalescence was uneventful.

CASE 45. Reported by Ladd. Female, 8 years of age. The patient had been losing weight for several months. When first seen, she complained of distended abdomen, headache, malaise, and joint and muscle pain of 5 days' duration; there had been no vomiting. Her white blood count was 10,500. There was found a large tumor mass on the right side of the abdomen which shifted to the hypogastric region. Cystoscopic examination was negative. At operation a large cyst measuring 13 by 8 by 6 centimeters was removed from the omentum. Its pedicle was twisted. Recovery was satisfactory. Microscopic examination showed a fibrous wall with a few strands of smooth muscle within it, and also some aggregations of lymphocytes. There was no epithelial lining. The pathological diagnosis was omental cyst of lymphatic origin.

CASE 46. Reported by Ryan. Male, 4 years of age. The abdomen had been large since birth, and was tapped at 2 years of age, when a large amount of brown fluid was removed. The swelling recurred again and respiratory embarrassment appeared. A smooth, "doughy" mass was palpable in the upper mid-abdomen. Operation showed a multilocular cyst of the great omentum, forming a group of nine endothelium lined cysts with many small, round fibrotic masses in their walls. Convalescence was uneventful.

CASE 47. Reported by Rau. Male 24 years of age. A tumor in the left hypochondrium the size of a marble was first noted 7 months earlier. This had grown rapidly to the size of an orange. Hæmaturia was also present for 3 months. The operation showed a cyst in folds of the great omentum which was easily peeled out. The tumor was 5 inches in diameter and contained white, milky fluid; its lining was thin and shiny. Recovery was uneventful. The blood disappeared permanently from urine 5 days after operation. No microscopic report was made.

CASE 48. Reported by Howe. Male infant, aged 2 years. The patient had had a left inguinal hernia since 6 weeks of age. At age of 1½ years, this became irreducible and 3 weeks later was operated on. Before operation the tumor in the groin was the size of a small cocoanut, fluctuant and translucent. It could be partially reduced. The diagnosis of hydrocele was made. At hernial operation a large, single cyst with 20 ounces of clear, dark yellow fluid was removed; this had one small diverticulum. No microscopic description was given.

CASE 49. Reported by Grausman and Jaffe. Male, 44 years of age. For several months, the patient had right lower abdominal pain with indefinite abdominal symptoms. On examination there was found diffuse abdominal tenderness, and a white cell count of 14,000 with 86 per cent of polymorphonuclear cells. At operation a large cystic omentum was found and removed. Hundreds of cysts varying from 1 millimeter to 2 centimeters in diameter were present. These were endothelium lined and contained clear fluid. The omental lymphatics were dilated and lymphoid cell infiltration with follicle formation had occurred. Recovery was uneventful.

CASE 50. Reported by Fisher. Male, 4 years of age. Abdominal pain and distress were present for 3 days. Examination revealed a large fluctuant abdomen with numerous dilated veins, a hard mass in the upper left quadrant with pain felt on pressure and reflected to the left inguinal region and causing marked flexure of both thighs. The white blood count was 13,050 with 75 per cent polymorphonuclears. Temperature was 100 degrees. At operation a large multilocular cyst and several smaller ones were found within the omentum. The entire omentum was removed; it weighed 12 pounds. Convalescence was uneventful, and there was no evidence of recurrence 1 year later. Microscopic examination showed the cysts to have a lining of flattened endothelium; in addition many cavernous lymph spaces ramified through the omentum.

CASE 51. Reported by Wyatt in Minnesota Med., 1931, 14: 656. Female, aged 3½ years. For 2 days child had had symptoms of acute appendicitis with fever, vomiting, abdominal pain, and rigidity. At operation 1,000 cubic centimeters of green fluid was found in the abdomen. A large multilocular cyst in the great omentum measured 5 by 3 by 5 centimeters. One large chamber had ruptured. Microscopically the cysts had an endothelial lining.

SUMMARY

Two cases of lymphangiomata of the omentum are reported in detail and 51 were found in a careful survey of the literature up to date.

These tumors are true neoplasms and about two-thirds of them have occurred in children.

The symptoms produced by these tumors are due either to their size or to twisted pedicles.

They can be permanently removed by simple surgical treatment with little risk to the patient.

BIBLIOGRAPHY

1. ARZELA, I. Contributo anatomo-pathologico e clinico allo studio delle cisti lingatiche delgrande epiploon Policlinico (Rome); sezione chir., 1922, 23: 417.
2. BERNADET, G. Serous cyst of great omentum. Gynec. et. obst., 1925, 11: 347.
3. BLOODGOOD, T. C. Letter included as part of article by Kenney and Mason.
4. BORSCHERS, E. Beitr. z. klin. Chir., 1920, 118: 711.
5. BOYD. Clin. J., 1903, 30: 564.
6. BRAITHWAITE. Lancet, Lond., 1898, 11: 1472.
7. BRANDT. Omental Cyste. Centralbl. f. Gynaek., 1894, 18: 991.
8. CAZIN. Bull. Soc. anat. de Par., 1893, 68: 312.
9. COSTA. Gior. internaz. d. sc. med., Napoli., 1908, 30: 355.
10. COSTA, T. Gior. internaz. d. sc., 1908, 30: 357.
11. DEWITSKY and MOROSOW. Arch. f. Kinderh., 1905, 13: 247.
12. EDEBOHLS. New York J. Gynec. & Obst., 1893, p. 614.
13. ERDHEIM. Wien. klin. Rundschau., 1896, 10: 131.
14. FISHER, W. H. Lymphangioma of omentum. Ann. Surg., 1928, 87: 872.
15. FORT. Ann. Surg., 1907, 14: 3,382.
16. FRANK, L. Omental cysts with report of a case. Am. J. Obst., 1913, 67: 501.
17. FUNK. Surg., Gynec. & Obst., 1914, 18: 70.
18. GIANNETTASIO. Gazz. d. osp., 1907, 38: 939.
19. GAIRDNER. Tr. Path. Soc., Lond., 1851, 52: 374.
20. GIFFORD. Brit. M. J., 1910, p. 1289.
21. GIRVIN and SPEESE. Ann. Surg., 1921, 74: 792.
22. GOODING. Lancet, Lond., 1887, 311.
23. GRAUSMAN, P. M., and JAFFE, H. L. Cystic lymphangioma of the greater omentum. Ann. Surg., 1928, 87: 66.
24. HALSTED, W. S. Self-eventration of large abdominal hygroma. Bull. Johns Hopkins Hosp., 1920, 31: 13.
25. HASBROUCK, E. M. Enormous endotheliomatous cyst of great omentum. Ann. Surg., 1908, 48: 206.
26. HEARN. Ann. Surg., 1897, 25: 1,703.
27. HOLLEMAN. Zentralbl. f. Gynaek., 1908, 32: 297.
28. HOWE, F. Omental cyst in inguinal hernia. Brit. M. J. 1928, 716.
29. JACOBI. Tr. Ass. Am. Phys., 1901, 16: 232.
30. KAKUSCHKIN, N. M. Lehre von den Geschwuelsten des grossen Netzes. Zentralbl. f. Chir., 1908, 35: 247. (Original reference—Russki Vrach, Moskow, 6, 1907).
31. KARAS. Arch. f. path. Anat., etc., Berl., 1907, 188: 138.
32. KENNEY and MASON. J. Nat. M. Ass., 1916, 8: 87.
33. LADD, W. E. Two cases of omental cyst and one of mesenteric cyst. Am. J. Dis. Child., 1926, 32: 701.
34. LAWRENCE, C. S. A case of cyst of omentum with twisted pedicle. South. M. J., 1925, 18: 423.
35. LEINATI, F. Lymphangio—endothelioma, case. Atti. d. r. Accad. d. fisiocrit. di Siena, 1928, 3: 93.
36. LEWITSKY, W., and MOROSOW, A. Sackformigl. Lymphangiom des grossen Netzes. Arch. f. Kinderheilk., 1905, 42: 247.
37. MARFAN. Presse méd., 1896, p. 133.
38. MARKOE and MCPHERSON. Am. J. Obst. 1913, 67: 507.
39. Idem. Bull. Lying-In Hosp. New York, 1912, 8: 70.
40. MARSH and MONSARRATT. Brit. M. J., 1901, 1: 511.
41. MATTHEWS. Brit. M. J., 1905, 11: 1642.
42. OUTERBRIDGE. Ann. Surg., 1914, 60: 680.
43. PYLBUS, F. C. Omental cyst. Lancet, Lond., 1917, 1: 63.
44. RAU, B. S. Hæmaturia relieved after removal of cystic tumor of great omentum. India Med. Gaz., 1926, 61: 599.
45. RODMAN. Ann. Surg., 1909, 49: 427.
46. RYAN. Cysts of omentum. Ann. Surg., 1926, 84: 567.
47. SCHRAMM. Zentralbl. f. Chir., 1903, 30: 564.
48. SCHWARZENBERGER. Beitr. z. klin. Chir., 1894, 11: 713.
49. SEEFISCH. Deutsche med. Wchnschr., 1909, 35: 1790.
50. SIMON. Bull. Soc. anat. de Par., 1858, 33: 30.
51. SPEESE, T. Strangulation of omental cyst from twisted pedicle in a child. Internat. Clin.—30th series, 1920, 2: 246.
52. STILLMAN, S. Lymphangiomata of the omentum and omental cysts. J. Am. M. Ass., 1911, 57: 726.
53. VILLAR. J. d. méd. de Bordeaux, 1908, 38: 219.
54. WAKEFIELD. Surg., Gynec. & Obst., 1907, 5: 227.
55. YOUNG. Lancet, Lond., 1905, 1: 157.

BRANCHIAL CARCINOMA

Lateral Cervical Neoplasm

GEORGE CRILE, M.D., F.A.C.S., AND J. E. KEARNS, JR., M.D., CLEVELAND, OHIO
Cleveland Clinic

THE fact that less than 100 cases of branchiogenic carcinoma have been reported in the literature, and that the largest single series that we have been able to discover is that reported by Lorenz, who reports but 8 cases, makes it appear that it would be of interest to present our observations in a series of 28 cases seen by one of us at Lakeside Hospital and at the Cleveland Clinic. Although branchial carcinoma is among the most malignant lesions, and the disease is usually fatal, nevertheless, it is well to accumulate experience in the treatment of the lesion in order to find what therapeutic methods offer the best chance of relief or of temporary cure.

Branchial carcinoma was probably first described by von Volkman, in 1882, as a tumor of the neck for which no source could be found in the skin, lymph glands, nose, mouth, pharynx, ears, or œsophagus. (Essentially the same factors are present in the diagnosis today.) Hudson presented a series of 6 cases of "so called branchial carcinoma" in which 5 came to autopsy and revealed other sources to account for the lesion. However, in view of all the evidence available today, such a pathological entity surely exists, although its exact mode of origin is obscure.

CLINICAL PICTURE

The total number of cases of branchial carcinoma in our series is 28, all of which were studied pathologically and were definitely diagnosed. Autopsy in 1 case disclosed no other site of malignant change. For comparison with the data on malignant branchial lesions, 70 cases of benign cysts have also been studied and presented in a few of the tables. Our results closely approximate those of Shedden.

The age of occurrence of lateral cervical carcinoma, as is the case with most carcinomatous lesions, falls in the latter decades of life. Two-thirds of the patients in this series had attained the age of 50 years, while nine-tenths were more than 40 years of age. The oldest patient was aged 80 years, and the youngest was a man aged 37 years. Comparisons between the ages of occurrence of benign and malignant lesions in our series are shown in Table I and Figure 1.

Branchiogenic carcinoma seems to occur more frequently in men than in women, but no relationship between incidence and the occupation of the patient could be demonstrated. There is approximately an equal distribution of lesions between the two sides of the neck, but bilateral occurrence was noted once in our series. The growth of the malignant tumors is rather rapid as compared with those of a benign nature. In the case of the malignant tumors, the longest period before the patient appeared for treatment was 3 years, with an average of about 7 months, while in the case of the cystic lesions the longest period before the patient presented himself for treatment was over 4 years. Nine-tenths of the patients with branchial carcinoma reported the speed of the growth as rapid, while only one-third of those with cysts showed rapid increase in size which is seen chiefly in the younger patients (Tables II and III).

The site of branchial carcinoma is usually high in the neck below the angle of the jaw or in close proximity to the ear near the sternocleidomastoid muscle (Fig. 2). Only one patient in this group had a lesion close to the clavicle (Fig. 3). The occurrence of pain is fairly frequent and this is referred to the side of the face, back of the head, shoulder, base of the tongue, and down the arm on the affected side. In the early stages the pain usually is intermittent, but, because of the close proximity of the growth to the nerves and their early involvement, the pain soon becomes quite severe and continuous. In some cases there was a specific involvement of the seventh, eighth, and ninth nerves and in 1 case a definite Horner's syndrome was present, due, of course, to the involvement of the cervical sympathetic system. Three-fourths of the patients with carcinoma complained of pain while only one-tenth of the patients with cystic lesions had this symptom (Table IV).

Malignant branchial tumors do not have a constant size, but usually average about 3 to 4 centimeters in diameter and are very firm in consistency unless degeneration has occurred, or a cyst is also present. Usually the tumor is not fixed to the skin unless some manipulation has preceded the examination, but it is very firmly attached to the underlying structures. In the differential diagnosis it is of interest to know that the cystic lesions are seldom attached to the underlying

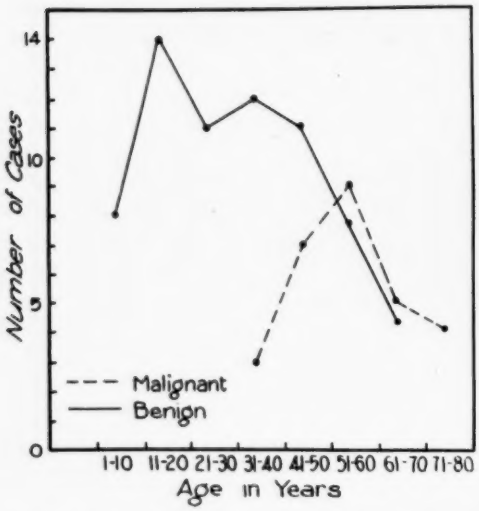

Fig. 1. Comparison of age incidence of benign and malignant branchial tumors in our series of cases.

structures, and never to the skin unless they have become secondarily infected and break through.

When patients with branchial carcinoma are first seen, they usually are enjoying fairly good health. About 25 per cent showed some weight loss, and 30 per cent had a definite anæmia. The previous health is seemingly irrelevant as most patients do not even report any previous upper respiratory infection, and in only 1 case could the presence of tuberculosis be demonstrated in the pathological tissue removed. A positive Wassermann reaction was found in 1 case.

Of the patients in the series who had an ear, nose, and throat examination, in only 2 was it felt that lesions which might possibly account for

TABLE I.—AGE INCIDENCE OF BRANCHIAL LESIONS

Age in years	Benign		Malignant	
	Cases	Per cent	Cases	Per cent
10 or under	8	12		
11–30	25	38		
31–50	23	34	10	35
51–70	11	16	14	50
Over 70			4	15
Youngest	Newborn		37 years	
Average	29 years		58 years	
Oldest	68 years		80 years	

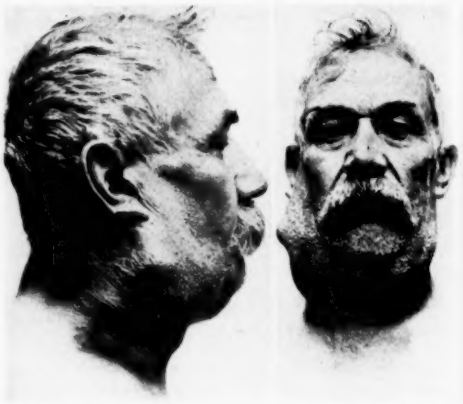

Fig. 2. Lateral branchial tumor in a patient 58 years of age; duration of tumor growth 2 months. This is a typical location and shows the very rapid growth that may occur.

the tumor as a metastatic growth were demonstrable. In 1 of these cases it was thought that there was a carcinoma of the larynx, but at necropsy the growth proved to be a direct extension of the branchial carcinoma in the pyriform sinus. In the other case there was a demonstrable mass in the posterior nasopharynx, but on removal of the tumor in the neck a typical pathological lesion could be seen in a cyst wall.

In 11 of the cases in our series roentgenograms of the chest were made and in 3 definite metastases were evident. In 2 cases there were palpable inguinal and axillary lymph nodes. Roentgen examination of the skull, jaw, and œsophagus in several cases demonstrated no pathological change.

The family history is of no importance as only one patient in the group reported the occurrence of cancer in the family.

DIAGNOSIS

In making the differential diagnosis, all tumors of the neck, including mixed tumors, must be considered. Among the more common of these conditions is tuberculosis of the cervical glands, especially when some degenerative process is present. Usually tuberculosis occurs earlier in life than does branchial carcinoma, and there are many nodules rather than a solitary tumor. Leucæmia and Hodgkin's disease may be differentiated by blood counts. The diagnosis of a lipoma when it lies above the fascia is readily made, but when the tumor lies deep, the diagnosis is quite difficult and often the nature of the growth can not be determined until the neck is incised.

Metastatic lesions may occur in the jugulodigastric glands from the ear, nose, or throat, and it should be borne in mind that in chronic retropharyngeal abscess these glands become quite firm, hard and tender, and lymphosarcoma also must be ruled out.

Thyroglossal cysts and adenomata of the thyroid gland must be differentiated, but these usually lie in the midline. A few of the rarer lesions such as aneurism, deep seated hæmangioma, cystic hygroma, and solitary lymph cyst must be considered, but most of these conditions must be treated surgically so a definite diagnosis is not essential before operation. It should be remembered that aspiration of a branchial cyst yields a typical fluid.

TREATMENT

The only available methods of treatment of branchial carcinoma are radiation with radium or the X-ray or both, and radical removal.

Dr. U. V. Portmann feels that radium can not be used in adequate doses without causing a sloughing of the great vessels which are in such intimate relation with the tumor. The tumor is resistant to roentgen therapy but this is administered to help relieve the pain. Portmann makes an attempt to keep the tissues saturated with the radiation for a considerable period of time. Short wave lengths should be used and a full erythema dose administered for one course of treatment which may be repeated once if necessary. Since branchial carcinoma is highly resistant to radiation, roentgen treatment is purely palliative.

The method of treatment employed in most of our cases has been a combination of surgery and X-ray. The pre-operative care of the patient is of little consequence except for the possibility of radiation before the procedure, and in cases of profound anæmia the use of blood transfusion, especially in elderly patients. Nitrous oxide anæsthesia should be employed. Local anæsthesia should be avoided as there is the possibility that infiltration into the area may spread the malignant cells.

OPERATION

In the removal of branchial carcinoma the incision should be made over the tumor parallel to the ramus of the jaw, the middle of the incision being over the tumor. At this point, when necessary, a cut may be made parallel to the sternocleidomastoid muscle which should be long enough to give an adequate exposure. In most cases, the skin may be saved in its entirety, for usually the neoplasm has not extended to it, but in a few cases in which previous treatment has caused the tumor to spread to the skin, it must be sacrificed. As is true of dissection of cancer anywhere in the body, the preservation of anatomical structures should not be considered. It is most important that the dissection be made with a sharp knife, thus avoiding all traction or pulling of the tissues.

Fig. 3. Lateral branchial tumor in a patient 48 years of age; duration of tumor growth approximately 12 months. This photograph is included to show our one case in which the location of the lesion was atypical. The incisions which are present were made before the patient was seen here.

The muscular structures which should be removed are the sternocleidomastoid, thyrohyoid and other infrahyoid muscles, the rectus capitus anticus major, digastricus, and at times the anterior scalenus muscle.

The lymphatics are of little import and should be completely removed. There is little evidence of the occurrence of lymphœdema after the re-

TABLE II.—DURATION* OF BRANCHIAL LESIONS

	Cysts	Carcinoma
Shortest period	2 weeks	10 days
Average period	4 years, 6 months	7 months, 2 weeks
Longest period	34 years	3 years

*Period before patients presented themselves for treatment.

TABLE III.—COMPARISON OF RATE OF GROWTH OF BENIGN AND MALIGNANT BRANCHIAL LESIONS

	Benign		Malignant	
	Cases	Per cent	Cases	Per cent
Slow	21		2	7
Rapid	23	37	25	90
Alternating increase and decrease in size			1	3

Fig. 4. Branchial tumor on the right side of the neck; duration of tumor growth 3 months. Left, photograph of patient, 50 years of age. Right, section of tumor showing not only malignant change but a few scattered giant cells suggesting an old tuberculous infection.

moval of the lymphatic chains from both sides of the neck. The only vein of any consequence which is involved in the dissection is the deep or internal jugular. This vein has been tied and resected in so many instances that it need only be mentioned.

The important artery to be considered is the common carotid. When this is resected, anastomoses are made through the vertebrals, inferior and superior thyroids, and the deep cervical arteries supplying the circle of Willis. The literature shows that the mortality rate following ligation of this blood vessel is 12.5 per cent and that about 25 per cent of the patients show some subsequent mental change. The proportion of deaths and psychoses among older patients after ligation of the common carotid is even higher, and since most patients with this disease are beyond middle life, every effort should be made in order to save this vessel.

OPERATIVE RESULTS

The most common immediate operative result is a collection in the wound of a large amount of serum which is troublesome because it tends to push the skin away from what is left of the underlying structures. This can be prevented by the application of large pressure dressings over this area. We use skin clips with a few black silk stays and have found that this is a very satisfactory method of closure.

Of course, as in all elderly patients, the immediate danger is that of pneumonia, and this caused 2 of the 4 postoperative deaths in our series. Of the 2 others, 1 died from shock, and the other following a laryngectomy.

In 1 of the patients in this series a postoperative psychosis developed, but there was a history of some senile change before the operation, and at the time of writing this patient is still living 3 months after operation but has shown very little mental improvement.

There usually is no difficulty in the muscular movement of the head after the immediate trauma and stiffness have subsided.

The damage to the sympathetic system is evident immediately and no improvement in this respect is ever noted. The pupil on the side operated upon is contracted and ptosis of the lid develops, caused by a paralysis of Mueller's muscle resulting from the cutting of the superior cervical ganglion. When the vagus nerve is cut,

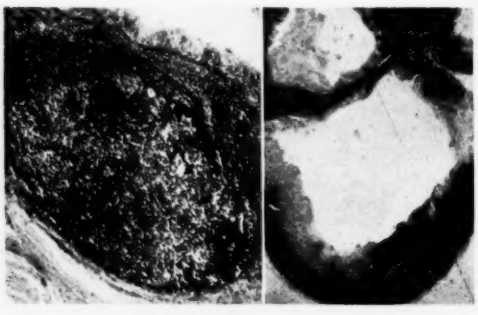

Fig. 5. Photomicrographs of sections of a branchial tumor removed from a patient 51 years of age; duration of tumor growth 6 weeks. Left, photomicrograph, x 100. Right, photomicrograph showing the definite cystic nature of the lesion, x 100.

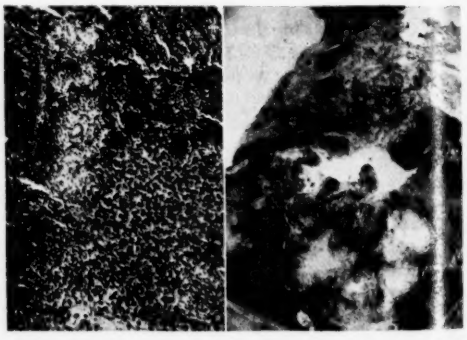

Fig. 6. Photomicrographs of sections of a branchial tumor removed from a patient 56 years of age; duration of tumor growth 12 months. Left, photomicrograph, 90. Right, photomicrograph showing a larger area with a cyst wall in the lower portion, x 90.

an immediate change in the rate of respiration is noted and also a rapid increase in the pulse rate. The vagus nerve on the right side of the neck is supposed to have less influence on the heart and gastro-intestinal tract than does the vagus nerve on the left, although, in our experience, the cutting of this nerve on either side produced little or no permanent effect. Most of the respiratory and cardiac changes disappear within 24 hours.

Paralysis of the vocal cords is permanent, of course, and the patient always has some huskiness of the voice. The phrenic nerve lies beyond the structures involved and is usually avoided at operation, but, if it were cut, there might be a collapse of the lung on that side.

END-RESULTS

In this series of cases, 11 patients were treated by surgery alone. Two died from postoperative bronchopneumonia. Five left the hospital, 4 of them in good condition on discharge, but the fifth was unable to swallow on account of paralysis of the glossopharyngeal nerve. Two of the 4 remaining patients died, respectively, 9 and 10 months after operation. Two are still living, 1 in very poor condition at the end of 1 month, and the other is alive at the end of 3 months with a postoperative psychosis.

Six patients were treated by surgery and postoperative deep roentgen radiation. One of these died following a laryngectomy which was performed because of the extension of the tumor into the pyriform sinus. Two others have died, 1 at the end of 3 months after operation after only one course of roentgen radiation; the other at the end of 11 months after operation following three courses of radiation over the entire side of the neck and head. Two are living at the end of 2 months after operation but 1 of these patients is in very poor condition because of metastasis to the lung, and the other patient in this group is in very poor condition 4 months after operation.

One patient, who was treated with one course of radiation preceding operation, and postoperative radiation with roentgen rays and 2,080 milligram hours of radium, died 12 months after operation.

Another group of 5 patients was treated only with roentgen radiation distributed over the head and neck. These all received at least 1 complete course averaging about 60 per cent of an erythema dose at each treatment. Two of these patients died within 3 months, and a third lived 7 months. The fourth patient is in poor condition at the end of 1 month after treatment. The fifth patient is living 4 months after the first treatment and 8 months after the lesion was first noted, and is apparently in good health.

One patient was treated with radium alone, receiving 2,340 milligram hours at the first treatment and 2,600 milligram hours 2 months later, and died 6 months after the first treatment.

Four patients were treated with both roentgen and radium radiation and all died within a period of 9 months after the first treatment. The patient who received the smallest dose of X-ray and radium lived the shortest length of time after the treatment, and the one who received the largest amount both of X-ray and radium had the next shortest survival period; the patient who received the next to the smallest dose lived the longest (9 months).

In 8 cases, not included in this series, there was a clinical diagnosis of a branchial tumor but no pathological examination. These patients received no treatment and their average duration of life after their first examination was approximately 6 months.

These data show that the results of treatment of branchial carcinoma are not good, no matter what the treatment, but in view of the fact that Roeder has reported that 1 patient treated by radical operation and roentgen radiation has survived for more than 4½ years, we feel that every patient should be subjected to these therapeutic procedures, with the hope that perhaps a few may be definitely benefited.

PATHOLOGY

The pathological picture presented by these cases of branchial carcinoma is that characteristic of squamous cell carcinoma. Grossly, if the origin of the tumor is a cyst, there is usually some evidence of the cyst wall and often a definite capsule infiltrated by the tumor can be demonstrated. The blood supply usually is scanty and gives rise to the frequent areas of necrosis, as well as the hyaline degeneration. Often a flaky, yellow, semisolid content typical of that seen in a simple cyst is noted, and the neoplastic change may involve only a portion of the cyst lining.

Microscopically, there is a fibrous tissue stroma with the tumor cells arranged in whorls of branching cords with no evidence of connective tissue between the cells. In addition, there may be noted nests containing cells more densely packed together, showing typical pearl formation. The cells themselves are polyhedral in shape and irregular in size, with the nuclei taking varying amounts of stain. A frequently noted fact which

TABLE IV.—INCIDENCE OF PAIN WITH BRANCHIAL LESIONS

	Cysts		Carcinoma	
	Cases	Per cent	Cases	Per cent
Present	11	18	17	61
None	35	56	6	21
Not mentioned	16	26	5	18

is significant of rapid growth is the remarkably large number of mitotic figures, with many of them asymmetrical and bipolar. This growth, together with the poor blood supply, leads not only to gross areas of necrosis, but to numerous isolated degenerating cells and cell groups showing caryolysis and isolated groups of nuclear granules (Figs. 4, 5, and 6).

PATHOGENESIS

Branchial or branchiogenic carcinomata arise from embryonic rests which for some unknown reason are stimulated into growth. As would be expected, therefore, they frequently are associated with branchial cysts, and therefore a study of the embryological etiology of branchial cysts may throw some light upon the pathogenesis of branchial carcinoma.

A brief review of the literature regarding the embryological etiology of branchial cysts shows that there are numerous hypotheses, each and every one of which seems to explain, at least in part, the presence of such abnormalities. The histological elements in these cysts, namely, connective, lymphoid, and epithelial tissue, are evident in the embryonic structures in all theories presented. It may be true that each has its individual application and that, when branchial carcinomata are studied, all these hypotheses must at least be considered as factors. The evidence at the present time seems to point toward Wenglowski's theory as the most acceptable.

In 1912, Wenglowski published one of the most important single contributions on the etiology of cervical cysts and fistulæ. This has been translated by Meyer. His papers are the result of intensive work over a period of 5 years. He concluded that sufficient evidence is shown to prove that branchiogenic rests may be limited above by the jaw and below by the hyoid bone; that cysts and sinuses found outside this area along the mesial border of the sternocleidomastoid muscle and above the suprasternal notch are anomalies occurring in the so called "thymacopharyngeal" duct.

Christopher greeted this theory very favorably and felt that it completely abolished the branchiogenic theory regarding the origin of branchial carcinoma. Shedden was hesitant and presented a table of Wenglowski's conclusions as criticized by Kingsley which substantiated his doubts concerning the ability of this hypothesis to explain all the abnormalities in this area.

Frazer (5) suggested that these abnormalities may be the result of "placodal cysts" or ducts, or of the ectodermal "external pharyngeal" ducts which are connected with the entodermal pouches, and this author has also shown the embryological relationship between the branchial cysts and the hypoglossal nerve. Hyndman and Light suggested essentially the same idea.

Not to be forgotten are the important early contributions to this subject by Rathke, Bland-Sutton and Cusset. The last 2 authors concluded that if any abnormality in growth should cause the arches to obliterate the grooves, a fistula or cyst might result; and that these pathological conditions might occur at levels corresponding to the various unobliterated clefts. Another interesting hypothesis was advanced by Rabl who felt that these anomalies arise from an improper obliteration of the cervical sinuses.

SUMMARY

1. Branchial carcinoma is a distinct pathological entity. It is comparatively rare; less than 100 cases have been reported in the literature.

2. Branchial carcinomata arise from embryonic rests which for some unknown reason are stimulated into growth.

3. Because of the rarity of this lesion and its high degree of malignancy, which demands every resource for palliation and prolongation of life, a series of 28 cases, diagnosed pathologically as branchial carcinoma, is reviewed with special reference to treatment.

4. The clinical picture is described and the conditions to be considered in the differential diagnosis are listed.

5. The method of treatment by surgery and by radiation is described, and the immediate and remote results are recorded.

6. Only palliative results and the prolongation of life can be expected from any treatment, as the disease is usually rapidly fatal. From available evidence, it seems probable that radical excision followed by radiation offers the best chance of relief to the patient with branchiogenic carcinoma.

The authors wish to thank Miss Amy Rowland and Dr. Allen Graham for their assistance in producing this paper.

REFERENCES

1. BLAND-SUTTON, J. On branchial fistulæ, cysts, diverticula and supernumerary auricles. J. Anat. & Physiol., 1887, 21: 289–298.
2. CHRISTOPHER, F. Surgical treatment of lateral cervical fistulæ. Surg., Gynec. & Obst., 1924, 38: 329–335.
3. CUSSET, J. Étude sur l'appareil branchial des vertébrés. Thèse de doct., Paris, 1877. No. 174.
4. FRAZER, J. E. Nomenclature of diseased states caused by certain vestigial structures in the neck. Brit. J. Surg., 1923, 11: 131–135.
5. Idem. Disappearance of precervical sinus. J. Anat., 1926, 61: 132–143.
6. HUDSON, R. V. So-called branchiogenetic carcinoma: its occupational incidence and origin. Brit. J. Surg., 1929, 14: 280–294.
7. HYNDMAN, O. R., and LIGHT, G. Branchial apparatus; its embryologic origin and pathological changes to which it gives rise, with the presentation of familial group of fistulas. Arch. Surg., 1929, 19: 410–452.
8. LORENZ, H. E. Das branchiogene Carcinom. Beitr. z. klin. Chir., 1913, 85: 599–632.
9. MEYER, H. W. Congenital cysts and fistulæ of the neck. Ann. Surg., 1932, 95: 1–26; 226–248.
10. PORTMANN, U. V. Personal communication.
11. RABL, H. Ueber die Anlage der ultimobranchialen Koerper bei den Voegeln. Arch. f. mikr. Anat., 1907, 70: 130–173.
12. RATHKE. Cited by Meyer, op. cit.
13. ROEDER, C. A. Malignant degeneration of a branchial cleft remnant. J. Am. M. Ass., 1929, 93: 103–106.
14. SHEDDEN, W. M. Branchial cysts and fistulae. New England J. Med., 1931, 205: 800–811.
15. VON VOLKMAN. Cited by Ewing, James. Neoplastic Disease. 3d ed., p. 1023. Philadelphia: W. B. Saunders Co., 1928.
16. WENGLOWSKI. Cited by Meyer, op. cit.

RUPTURE OF THE KIDNEY PELVIS

Review of the Literature[1]

BENJAMIN S. ABESHOUSE, M.D., Baltimore, Maryland
From the Urological Clinic, Sinai Hospital

RUPTURE of the kidney pelvis is a relatively rare lesion of the kidney. The author has collected 61 cases of rupture of the kidney pelvis from the literature and has added 3 personal cases. In this series of 64 cases, there are 31 cases of traumatic rupture, 26 of the spontaneous type, 3 following instrumentation of the ureter and 4 following pyelography. These cases are grouped under their respective headings in the bibliography. It is possible, and indeed very probable, that many more similar cases have been encountered but have not been reported or are reported in connection with some other renal lesion, i.e., ruptured hydronephrosis, renocolic fistula, etc. and hence are not readily discernible in the rapidly increasing urological literature.

In this series, the author has collected only those cases in which the rupture is strictly confined to the pelvis of the kidney and has excluded those cases (a) in which the rupture has occurred at a terminal calyx (Fritz, 2 cases; Henline); (b) in which an associated rupture or tear occurred in the renal parenchyma; and (c) in which a perirenal, psoas or vertebral abscess opened into the renal pelvis.

True rupture of the kidney pelvis may be conveniently classified into the following two types: traumatic and non-traumatic or spontaneous. The traumatic type of ruptured pelvis, unassociated with a parenchymal injury, is more frequently encountered than the spontaneous type and is usually observed in those cases of ruptured hydronephrosis in which the external force is sufficient to produce an uncomplicated rupture of the thin pelvic walls found in pyelectasis. The spontaneous type of ruptured pelvis usually occurs in those patients who have associated pathology in the upper urinary tract, i.e., pyelitis or hydronephrosis secondary to an inflammatory lesion or congenital or acquired obstruction (stone, stricture, etc.) of the ureter or pelvis.

ETIOLOGY

There are various extrinsic and intrinsic factors or conditions which may serve as predisposing or etiological agents in the production of a rupture or perforation of the renal pelvis. The most common extrinsic factor is trauma of a direct or indirect nature. The most important intrinsic factors are (1) infections of the renal pelvis, (2) stone or stricture in the pelvis or ureter, (3) hydronephrosis, (4) operative defects, (5) instrumentation, i.e., ureteral catheterization, and (6) syringe pressure pyelography. While some of these conditions bear a greater etiological significance than others, a brief consideration of each is presented.

Trauma. The etiological relationship of trauma to rupture of the kidney parenchyma has been repeatedly emphasized by many writers. A review of the important contributions to this subject is in order since the external forces concerned in the production of a rupture of the kidney pelvis are essentially the same as those responsible for a rupture of the kidney parenchyma. Rayer and Tuffier were the first to emphasize the fact that an injury to the kidney may be caused by the jarring from a direct blow on the body. LeDentu explained kidney injuries on the same basis as a brain injury due to a blow on the opposite side (*contre coup*). Schede pointed out the possibility of throwing a distended kidney against the transverse process of a vertebra while Morris attributed a similar rôle to the floating ribs. Kuster has stressed the effect of hydraulic pressure acting through full blood vessels and a distended pelvis and causing the organ to burst along lines which radiate for the most part from the pelvis and tubules toward the point of maximum impact of the lower ribs, the opposing resistance being supplied by the vertebral column. Guterbock has suggested the possibility of a force so exerted that the poles of the kidneys are squeezed together producing transverse fissures and conceivably ruptures. Keen maintained that the line of cleavage follows the direction of the uriniferous tubules. Grawitz explained the tendency to radial fissuring on the basis of the fetal arrangements of the kidney but this theory lacks histological proof.

The most frequent modes of injury to the kidney parenchyma or pelvis are: (1) the application of direct force against the kidney, i.e., a fall, blow or compression which drives the kidney against the lower ribs or against the transverse processes or bodies of the lumbar vertebra; (2) the application of indirect force producing a concussion such as may occur following: (a) jarring the body as in landing on the feet after a fall, (b) undue muscular

[1]Read in Abstract in Section on Urology, Southern Medical Association, Twenty-seventh Annual Meeting, Richmond, Virginia, November 14–17, 1933.

effort as in sneezing, coughing, straining, lifting heavy objects, etc., (c) acute flexion or other sudden movements of the body; (3) penetrating forces such as a gunshot injury, stabbing, etc. The latter type is more likely to result in an injury to the parenchyma or vascular pedicle than to the pelvis.

At times it appears to be well nigh impossible to explain the occurrence of a rupture of the kidney parenchyma or pelvis following what appears to be a slight injury or inadequate force. The extent of the damage to the renal parenchyma or pelvis may be out of proportion to the degree or amount of the force. The direction of the force and the pathological and physiological condition of the kidney parenchyma and pelvis often determine the type of injury to these structures. It is the general impression that an infection or distention of the kidney parenchyma or pelvis greatly increases the susceptibility of that organ to rupture by external violence. This is borne out by the increasing number of reports of rupture of hydronephrotic kidneys in the recent literature. In many cases of traumatic rupture of the kidney, the laceration or tear in the kidney parenchyma is very often accompanied by a coincidental tear in the renal pelvis or the parenchymal rupture extends directly into the pelvis, but in such cases the pelvic rupture is always overshadowed by, and secondary in importance to, the parenchymal injury.

Infection. The etiological significance of an acute or chronic infection of the pelvic walls in production of a traumatic or spontaneous rupture of the pelvis has not been clearly established. The presence of such an infection, unaccompanied by a pelvic or ureteral obstruction, apparently has but little causative significance in cases of ruptured pelvis due to external violence other than producing a potential weakness of the pelvic walls which increases the susceptibility of the tissues to any type of injury. Undoubtedly, a pelvic infection plays a more important rôle in etiology of the spontaneous type of rupture. This contention is based on the fact that a rupture of the pelvis is more likely to occur in those cases where the pelvic walls have been weakened by an acute or chronic inflammatory process and are subjected to the influence of other factors such as an increased intrapelvic pressure or irritation from an impacted irregular stone. It can be readily understood how an ulcer with a thin base and inflamed margins may serve as a potential site for a perforation or rupture under similar conditions. Two cases of ruptured pelvis secondary to a chronic pyelonephritis were reported by Fritz and Mathe. In 10 cases the rupture occurred in a pyonephrotic kidney secondary to a calculus or stricture in the ureter or pelvis.

Stone or stricture in the upper urinary tract. The presence of a stone in the ureter or pelvis may influence, directly or indirectly, the development of a traumatic or spontaneous rupture of the pelvis. The pathological sequelæ of stone in the upper urinary tract, i.e., obstruction, retention, infection, and ulceration, are well recognized. Thus a ureteral or pelvic stone may be indirectly responsible for the rupture of the pelvis by virtue of the fact that these accompanying secondary changes in the pelvic walls increase the susceptibility of this structure to rupture following a mild or severe traumatic insult. If an infection supervenes, the thinned pelvic walls resulting from pyelectasis are further weakened so that any extrinsic or intrinsic pressure may produce a rupture of the pelvis. In the analysis of the reported cases it was found that a stone was present at the ureteropelvic junction in 3 cases, in the ureter in 9 cases, in the pelvis or calyces in 14 cases.

A stone in the upper urinary tract may be the direct cause of a pelvic rupture. When the calculus is small, smooth, and movable, the irritation and ulceration of the mucous membrane is insignificant. If the stone is large with irregular jagged surfaces and in a more or less fixed position, the ulcerating process may be more extensive and produce a localized area of necrosis which serves as an admirable site for spontaneous perforation. Should the stone by encysted or impacted, the ulceration progresses rapidly and deeply, involving all the layers of the pelvic wall, and soon results in a perforation with the escape of the pelvic contents, i.e., infected urine and occasionally the stone, into the peripelvic and perirenal tissues.

Any intrinsic or extrinsic obstruction of the ureter may be indirectly responsible for a rupture of the pelvis by virture of subsequent development of a hydronephrosis or pyonephrosis. In the case reported by Schmidt, the pelvic rupture occurred in a hydronephrotic kidney secondary to an aberrant vessel crossing the ureteropelvic junction. In one of the author's cases, a stricture at the ureteropelvic junction was the probable etiological factor responsible for the pelvic rupture.

Hydronephrosis. In 1909, Legueu distinguished three types of hydronephrosis associated with trauma, viz.: (1) true traumatic hydronephrosis—this type has all the physical characteristics of an ordinary hydronephrosis but owes its origin to some traumatism. The dilatation of the kidney pelvis occurs at the expense of the kidney paren-

chyma and is the result of a more or less complete obstruction of the ureter or pelvis by either a blood clot or a faulty reparative process in the injured kidney, pelvis or ureter; (2) pseudotraumatic hydronephrosis—this type is the result of an injury to the kidney, pelvis or ureter which is followed by an extravasation of urine, and occasionally blood, into the surrounding tissues, and by the development of a well defined sac about the extravasate. This condition is sometimes called pseudohydronephrosis and is seen most frequently in young individuals; and (3) ruptured hydronephrosis—in this type, a rupture of a preexisting congenital or acquired hydronephrotic kidney occurs as the result of direct or indirect trauma.

It is the latter type (group 3) which is of particular interest from the standpoint of rupture of the kidney pelvis, for by far the greatest percentage of cases of ruptured pelvis are cases of ruptured hydronephrosis. The author has reviewed 72 cases of ruptured hydronephrosis of both the traumatic and spontaneous forms and found that in 17 cases the rupture or tear was in the mucous membrane of the pelvis. An analysis of this series of 72 cases reveals the fact that ruptured hydronephrosis is most frequently associated with direct trauma although indirect trauma and muscular action is the responsible factor in a few cases.

A very slight injury may be the cause of rupture of a hydronephrotic kidney especially in children and adolescents as occurred in Lazarus's patient who developed a tear in the renal pelvis following a glancing blow received during a basketball game. In Schmidt's case, the rupture occurred while the patient was rowing. Herman states that in about 50 per cent of the cases of ruptured hydronephrosis, the renal injury followed what appeared to be insignificant trauma or was of such mild intensity and degree that it is safe to assume that similar injury would not cause more than a superficial bruise in a normal individual.

It is interesting to note that several cases of spontaneous rupture of a hydronephrosis have been reported. In many of these so called spontaneous ruptures, it is possible and very probable that either or both the patient and the physician have overlooked some mild form of trauma. However, there are several cases of spontaneous ruptured hydronephrosis in which a traumatic factor can be eliminated but careful examination in these cases practically always reveals some secondary etiological factor, i.e., pyelitis or stone.

While it is true that mild traumata or muscular action may produce a ruptured hydronephrosis in children it is difficult to conceive how these same agents can produce the same effects in adults with hydronephrosis. It has been the experience of every urologist to frequently encounter men with very large hydronephroses who are employed at very arduous mechanical trades or at heavy manual labor requiring unusual muscular effort and considerable use of intra-abdominal pressure and who continue to work at their trades for many years without damage to their diseased kidneys. A possible explanation for the greater incidence of ruptured hydronephrosis and incidentally ruptured pelvis in children and young adults is the fact that the kidney is situated at a lower level in children as a result of the persistence of the infantile type of ptosis as pointed out by Aglave. Other predisposing factors in children are the lack of protection of the lower ribs as suggested by Gibson and the diminished amount of perinephritic fat and increased tension of the posterior parietal peritoneum in the region of the kidney as maintained by Harrigan. The abdominal musculature is better developed in adults and can help ward off or minimize the effects of traumatic forces directed against the kidney.

Rupture of the pelvis following plastic operation. Spontaneous rupture or perforation may occur several weeks or months after a plastic operation on the renal pelvis. The occurrence of a rupture or perforation following a plastic operation on the pelvis may be attributed to a faulty operation and is due to either a recurrence of the old obstruction or to the production of a new obstruction. In either instance there results an increased back pressure which is exerted on the potentially weakened portion of the pelvis, namely, the suture line. These untoward results were frequently encountered in the early days of conservative plastic operations on the renal pelvis and were responsible for the slow recognition accorded this deserving operative procedure. However, when the proper precautions are taken at the time of operation to insure and institute good drainage by inserting a nephrostomy tube, splinting the ureter, etc., accurate healing occurs and unpleasant accidents are avoided.

Walters recently emphasized the postoperative complications which are likely to occur following plastic operations on the renal pelvis for hydronephrosis. He stressed: (1) the leakage of urine at the point of anastomosis with perirenal extravasation; (2) retention of the urine in the kidney leading to pyelonephritis or cortical

abscesses; and (3) ureteral obstruction at or below the pelvic incision with a persisting urinary fistula from the site of pelvic anastomosis. Three of the 8 cases, in which resection of the pelvis was done, later required a secondary nephrectomy due to persistent urinary fistula as a result of occlusion of the ureter by postoperative infection around the ureter (1 case) and pyelonephritis and cortical abscesses (2 cases).

Rupture of the pelvis following instrumentation of the ureter. Perforation of the renal pelvis by a ureteral catheter has been known to occur in rare instances. Hunner reviewed a series of over 20,000 cystoscopic treatments of the ureter by the Kelly method and reported 21 accidents which included 12 personal cases and 9 cases occurring in the practice of his associates. An incidence of one accident in each thousand ureteral catheterizations indicates a very low morbidity. Nevertheless, it serves to emphasize the fact that this procedure may be attended by an unpleasant complication in hands of inexperienced cystoscopists. In this series of 21 cases there were 4 cases in which the perforation occurred in the pelvis or in the upper third of the ureter near the ureteropelvic junction.

Wesson states that the wall of a normal ureter cannot be punctured by the ordinary ureteral catheter and maintains that it is doubtful if a diseased ureter can be perforated unless a deep ulcer is present. He pointed out that when the ordinary catheter is passed through the cystoscope and the tip of the catheter meets with the resistance of the urethral wall, the catheter will buckle. Similar results were obtained when a maximum pressure was exerted in passing a catheter up the ureter through the bladder of freshly obtained autopsy specimens. He is of the opinion that perforation can occur if a wire stylet is used or the catheter is equipped with a whalebone tip such as is used in the Kelly method of direct cystoscopy. In this connection, it is well to point out the danger of perforating the ureter when any one of the various metallic ureteral stone extractors is used. Wesson also showed that it is impossible to perforate the kidney capsule with an ordinary ureteral catheter.

Rupture of the pelvis as a complication of syringe pressure pyelography. One cannot stress too strongly the danger of producing a rupture of the pelvis in employing the syringe method of pyelography. Any pelvis or ureter whose walls have been weakened by the presence of a stone, chronic infection, abscess formation, tumor, etc., is a potential site for a rupture when too much pressure is exerted in injecting the pyelographic medium as has been pointed out by Hoffman, Hunner, Mathe, Hartman, Wesson, and Kindall. The syringe method of injecting the pyelographic fluid without manometric control should not be used in the diagnosis of those cases in which an impacted ureteral or pelvic calculus, chronic infection, abscess formation or tumor of the pelvis is suspected. The low pressure gravity is a safer procedure and practically devoid of the danger of perforation. In his discussion of Kindall's paper, Hunner stated that spontaneous rupture may follow even the gravity method if stricture or some other form of obstruction causes prolonged trapping of the fluid. Hoffman has reported 3 cases of perirenal suppuration following the use of 5 per cent collargol as a pyelographic medium. He maintained that under increased pressure, the collargol passes into the canaliculi and thence by rupture or diffusion reaches the perirenal tissues causing necrosis. In 1 case, the rupture occurred in the pelvis of a hydronephrotic kidney and spread into the peritoneal cavity. Kindall has recently reported 2 interesting cases of rupture following syringe pressure pyelograms. In 1 patient a calculus was present in the lower calyx of the kidney and a rupture of the kidney occurred and 2 days later a rupture of the ureter; the other patient had calculi in the kidney pelvis and ureter and developed a rupture of the pelvis.

PATHOLOGY

The pelvic lesion encountered at operation or autopsy may be either a laceration or a perforation on one of the surfaces of the pelvis, usually the posterior surface. Occasionally two tears may be present in the same pelvis. The laceration or tear in the pelvis is usually radial in character especially in cases of a ruptured hydronephrotic pelvis and appears to extend from a point near the ureteropelvic junction toward the hilum of the kidney in a direction corresponding to that of the uriniferous tubules. The size of a tear is more or less in proportion to the degree of back pressure and increased intrapelvic pressure causing the rupture. The nature and the direction of the pelvic laceration in these cases tends to indicate that the lesion is the result of a bursting rather than a break or crushing. This conforms with Kuster's theory on the mode of kidney rupture.

A pathologically or physiologically distended kidney pelvis ruptures more easily and following a lesser degree of violence than a normal undistended kidney. Furthermore, the extrarenal type of pelvis is more susceptible to rupture than the intrarenal type. In cases of rupture of a normal

kidney due to external violence, the parenchyma, being the softest and weakest portion of the kidney usually gives way first causing a tear which may extend into the capsule. However, if the pelvic wall has been weakened by a chronic infection or hydronephrosis, the rupture may be strictly limited to the pelvis. Occasionally, it may involve both the pelvis and the parenchyma. Spontaneous rupture of the kidney pelvis occurs only in those cases in which the pelvis has been pathologically weakened by dilatation or infection. The most common type of spontaneous rupture is rupture of the pelvis of a hydronephrosis secondary to an obstruction of the ureter or pelvis by a calculus. The rupture occurs as a result of a sudden or gradual alteration in the increased back pressure caused by an obstructive lesion in the upper urinary tract. Occasionally, a spontaneous rupture of the pelvis is caused by perforation of an impacted calculus. There have been no cases reported of spontaneous rupture secondary to a neoplasm of the renal pelvis.

Several cases have been reported in which the pelvis or ureter at the ureteropelvic junction have been partially or completely severed as a result of violence or external force directed against the distended kidney. It may be impossible to differentiate the rupture of the pelvis from a similar lesion of the upper portion of the ureter from a clinical standpoint. However, from an anatomical standpoint, a tear or perforation at the ureteropelvic junction may be considered just as much a lesion of the pelvis as of the ureter. In fact, it is often impossible to determine on close inspection of the affected organ, either at operation or at autopsy, the exact location or limitation of the rupture. A careful survey of the literature reveals the fact that true intraparietal rupture of the ureter is an exceedingly rare condition.

The most striking pathological feature of ruptured pelvis is the extravasation of urine into the surrounding tissues. This condition is rarely accompanied by the extravasation of blood inasmuch as there are no end arteries in the pelvis. The presence of blood in the extravasate is indicative of rupture of the parenchyma or a laceration of one or more of the blood vessels in the hilum of the kidney. It is possible that at the time of rupture of the pelvis there may develop an intrarenal rupture in the region of the pyramids of varying degree which may be responsible for a slight amount of bleeding and the presence of a small amount of blood in the extravasate.

When the actual amount of urine escaping through the pelvic rupture or perforation is scant and the urine sterile, the tissue reaction is prompt and localization of the extravasate may ensue with or without the subsequent formation of a circumscribed abscess in the peripelvic or perirenal tissues. If the extravasated urine is walled off and absorbed, these patients may recover without any surgical intervention and it is conceivable that cases of this type occur but are not recognized.

When the extravasation of urine is more extensive or continues for some period of time after the rupture, the tissue reaction may be less efficient particularly if the urine contains pathogenic organisms. In such a case the extravasated urine causes a diffuse inflammation in the surrounding tissues which soon results in suppuration and a rapidly progressive perirenal abscess. Occasionally, the perirenal abscess may rupture into the lung (Mathe), large bowel (Wesson), peritoneal cavity (Hammel, Rost, Kapel), or externally into the skin of the loin giving rise to the formation of a temporary or permanent fistula (Mathe, Turner, Higgins and Hicken, and one of the author's cases).

Vermooten and McKeown recently reviewed 34 cases of renal colic fistula. In 2 instances (Watson and Cunningham, Fuller), the fistula was found between the renal pelvis and the bowel. In all the other cases, the fistulous tract started in a calyx passing through the kidney substance into the bowel. They pointed out that renocolic fistulæ are always secondary to long standing suppurative lesions of the kidney which, as a rule, are associated with either a chronic perinephritis or a perinephritic abscess.

The author has reviewed the cases of fistula formation between the renal pelvis and the large and small bowel or bronchi reported in the literature and has recorded them under their respective headings in the bibliography. These cases are not included in the final tabulation of true cases of ruptured pelvis due to the fact that the etiological relationship is by no means clearly established in these cases.

The immediate pathological changes occurring in the affected kidney following a pelvic rupture depends upon the condition of the kidney before the injury and the extent of the inflammatory process in the perirenal tissues following the injury. The subsequent perirenal infection may assume the characteristics of an extensive gangrenous process or a devastating phlegmon which soon involves the entire perirenal tissues. The infection may invade the kidney proper and produce many cortical abscesses or a diffuse pyelonephritis.

The permanent pathological sequelæ which may follow the rupture of the pelvis depend

upon whether or not treatment is instituted. In those patients who recover without operative intervention due to the fact that the extravasation is slight and localization with absorption takes place, there may develop a cicatrizing or sclerotic process in the perinephritic tissues which may or may not cause trouble in the future. Occasionally the reparative process in the region of the tear is faulty and there develops a stenosis which may be responsible for the further development of a hydronephrosis or even stone formation. If treatment consists solely of preliminary incision and drainage and no attention is paid to the underlying lesion, the after effects of the rupture resulting from the suppurative process in the perinal tissues may be manifested in the form of a permanent fistulæ, kidney atrophy, infection of the opposite kidney, parenchymatous or interstitial nephritis, or future stone formation. In those cases in which the rupture of the pelvis occurs in the form of a partial or complete severance or tearing of the pelvis at the ureteropelvic junction, or in which the pelvis is completely severed from its attachments at the hilum of the kidney, primary healing is not likely to occur and there results a permanent fistula. In an occasional case, the injured tissues may heal with cicatricial contraction at the site of rupture which results in a partial or intermittent form of hydronephrosis as occurred in the case which has been reported by Bailey.

While this paper is particularly concerned with rupture of the kidney pelvis proper, it is interesting to note that rupture of the pelvis may also occur in any of its major or minor calyces. When the calyceal rupture is due to trauma, the laceration may extend partially or completely through the adjacent parenchyma (subparietal rupture) which results in an extravasation of blood and urine below the true capsule of the kidney and heals with little or no permanent damage to the kidney. Occasionally the calyceal rupture results in a distention of the calyx due to an intrarenal extravasation of urine which may extend through the cortex and under the kidney capsule. This process soon becomes walled off producing a cystic dilatation whose lining appears to be a continuation of the pelvic and calyceal mucous membrane. This walled off sac is known as a pseudohydronephrosis which may later rupture as in the case reported by Babitzki. In the same manner a pseudohydronephrosis may develop following a rupture of the true pelvis. This condition occurred in 6 cases of traumatic rupture (Hawkins, Stanley, Dodge, Wildbolz, and Bretanno, 2 cases).

AGE AND SEX INCIDENCE

The age and sex of the patients bear no unusual significance in cases of ruptured pelvis. The age and sex act as predetermining factors only in so far as they predispose to the development of an upper urinary tract lesion which increases the susceptibility of the kidney pelvis to ruptures, i.e., the development of a congenital hydronephrosis in infants and children, the occurrence of pyelitis of pregnancy, hydronephrosis, ptosis, and stone formation in women in the childbearing period. There were 4 cases of traumatic rupture in the first decade (Hawkins, 6 years; McAlpine, 7 years; Wesson, 8 years; and Martin, 8 years) and 4 cases in the second decade (Croft, 12 years; Lazarus, 15 years; Ewell, 16 years; and Rowland, 18 years). The youngest patient in the series of cases reviewed was 6 years of age (Hawkins); the oldest 77 years (author's case). The average age was 35.6 years. There were twice as many males (39 cases) as females (19 cases). This latter observation may be explained by the fact that the greatest number of cases were of the traumatic type and in this age of automobiles, trains and machinery and of competitive sports, men are subjected to greater hazards than women. The left kidney was the site of the pelvic rupture in 35 cases and the right kidney in 22 cases. There was 1 case of bilateral rupture (avulsion) reported by Osgood and Campbell.

SYMPTOMATOLOGY

There is no definite symptom complex associated with rupture of the kidney pelvis inasmuch as the presenting symptoms may differ in the traumatic and spontaneous types of pelvic rupture. The clinical signs and symptoms associated with this condition vary and are more or less dependent upon the etiological factor producing the lesion, the associated pathological process present in the affected kidney, and the length of time elapsing until the patient first comes under observation. In general, it might be stated that the most prominent signs and symptoms of ruptured pelvis are those attributable to perirenal extravasation of urine and perirenal abscess formation. The symptoms of ruptured pelvis may be conveniently classed into the following two groups: general, and localized.

General. From a clinical standpoint, ruptures of the pelvis may be divided into an acute and chronic form. The acute group includes those cases of sudden rupture of the pelvis secondary to trauma. In the acute form, the patient appears to be acutely ill soon after the rupture has occurred as a result of the sudden escape of urine producing

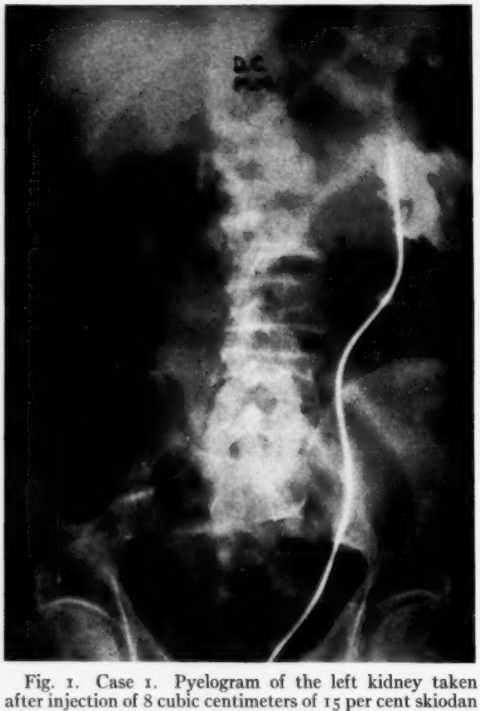

Fig. 1. Case 1. Pyelogram of the left kidney taken after injection of 8 cubic centimeters of 15 per cent skiodan solution (syringe method). The pelvis and lower major calyces are filled with the pyelographic medium. The upper and middle major calyces are not filled. The irregular blotchy appearance of the dye about the renal pelvis indicates an extravasation from the renal pelvis. The psoas outline can be discerned on the right side but can not be detected on the left side. The deviation of the spine is toward, rather than away, from the affected side. The diagnosis of perinephritic abscess was confirmed by the presence of the above roentgenographic findings which also established the etiological factor responsible for the abscess, i.e., rupture of the renal pelvis.

an immediate urinary infiltration of the perirenal tissues. As the pelvic contents continue to extravasate into the perirenal tissues, suppuration and abscess formation rapidly progress and the patient develops a severe toxæmia and occasionally passes into a state of shock which may precipitate a complete collapse and even terminate fatally. The chronic type proceeds slowly as in the case of a pelvic perforation due to an impacted stone or instrument. In such cases the urine is released slowly into the perirenal tissue and may collect in a preformed box of adhesions. A walled off perirenal abscess may form with the gradual development of a mass in the renal region. The symptoms of shock or collapse are usually absent. In fact the patient may not show any severe general reaction and even may continue about his daily work for several days unaware of the presence of a serious renal disease. Occasionally in the more chronic form, the extravasated urine or pus may proceed to burrow its way downward into the iliac fossa or upward with the formation of a subphrenic or perihepatic abscess. If the abscess penetrates through the bowel or skin the patient is relieved of much pain, fever, and discomfort associated with perirenal extravasation.

Symptoms of shock, i.e., pallor, cold extremities, cold perspiration, thin rapid pulse, vertigo, prostration, etc., are not commonly observed in cases of ruptured pelvis, unless the injury is caused by sudden external violence which may produce an unrecognized parenchymal tear or an intra-abdominal injury. In an occasional case symptoms of shock, usually of a mild nature, may be present at the onset but the clinical picture soon becomes one of the urosepsis due to the extravasation of urine. If the symptoms of shock persist, the examiner should be on guard for an unrecognized parenchymal tear or an intra-abdominal injury.

The first clinical manifestation of a pelvic rupture may be a chill followed by a high fever, which is due to the reaction of the perirenal tissue to the extravasated urine and to the absorption of fibrin ferment or of urine. An elevation in temperature is present in every case, although the temperature may be subnormal at first due to the initial collapse which is soon followed by an increase in the temperature and pulse rate. The elevation in temperature may become quite high if the extravasation in the perirenal tissue is unrecognized and infection and suppuration ensue. The fever may be continuous or intermittent in type. The pulse rate rapidly rises and remains elevated as a result of the toxæmia and infection. If the perirenal extravasation and infection are allowed to continue unrecognized and untreated, progressive weakness and eventually collapse set in. If the patient should survive the initial reaction, general malaise, cachexia, and anorexia soon occur. Jaundice may occur as in one of the patients reported by Mathe. The jaundice is either hæmatogenous in origin or is due to the pressure of the accumulated urine and pus in the perirenal tissue upon the liver, hepatic and common bile ducts.

Localized. This type of symptom is directly related to the rupture of the pelvis and is due to the effects of the extravasation of urine into the perirenal tissues. The development of a tumefaction in the involved loin or upper abdominal quadrant occurs in practically every case as

result of the liberation of urine into the peripelvic tissues. This swelling may appear immediately after the rupture as is the case in a traumatic or spontaneous rupture of the pelvis of a hydronephrotic kidney or it may develop slowly as in the case of perforation of the pelvis by a stone or an instrument. The extravasated urine and pus is soon responsible for the formation of a soft, elastic round mass which is more or less fixed and has very little movement during respiration. The mass may attain the size of a man's head (Bretano, Hammel) or a watermelon (Beach). Frequently the mass is indefinite and difficult to outline due to œdema, rigidity, and spasticity of the overlying abdominal and lumbar muscles. However, under inhalation or spinal anæsthesia, the resistance of these muscles can be overcome and the mass can be palpated with ease. There is in most instances exquisite tenderness over the involved area, anteriorly and posteriorly. The tumefaction may present fluctuation and ballottement.

Careful examination may disclose ecchymotic areas over the skin of the loin or abdomen which may be suggestive of a renal injury. The presence of fractures of the lower ribs is likewise suggestive of a renal injury. These findings are likely to occur only in those cases where the etiological factor is direct trauma, i.e., crushing injury or severe fall. The absence of these slight signs is not significant since severe renal injuries may result from indirect violence or very slight muscular effort which leave no tell-tale signs on the external surface of the body.

Pain is an important and prominent feature of every case. At the onset, the pain is usually sudden and severe. The patient may volunteer the information that he or she felt something break or give way (Brown and Schmidt). As the swelling increases in size, the pain is usually of a severe dull character as a result of the continuous irritation and distention of the perirenal tissues by the extravasated urine. The pain is occasionally referred to the upper and lower abdominal quadrant or to the inguinal region on the affected side but seldom radiates to the scrotum or thigh. It is rarely colic-like in nature, although renal colic may have been present before the rupture occurred.

In an occasional case, the pain may be more or less diffuse over the entire abdomen or spread over the upper and lower quadrants of the abdomen on the affected side but the pain soon becomes localized to the region of the kidney. This type of pain is associated with an extensive extravasation of urine in the perirenal tissues following a traumatic rupture of the hydronephrotic pelvis. The generalization of the abdominal pain is more likely to occur in those cases where a perforation of the pelvis and peritoneum with peritonitis has occurred or where the etiological factor is trauma of such severe intensity and direction as to produce an associated intra-abdominal injury. In the case of a perforation of the pelvis by a stone with a slow or slight amount of extravasation of urine, the patient may complain of no pain or discomfort and may continue at work for some time (Wesson).

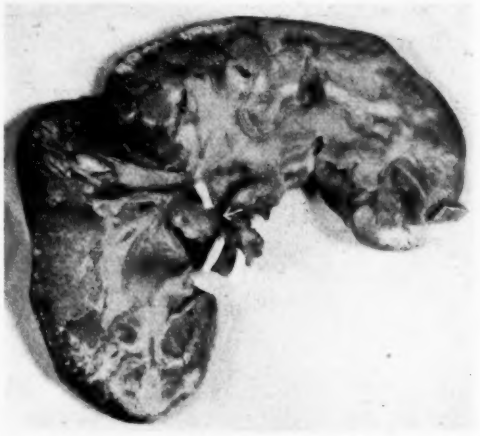

Fig. 2. Case 1. Photograph of the left kidney removed at operation. The three white pegs are inserted through the perforations. The arrow points to the stricture at the ureteropelvic junction. The dilatation of the renal pelvis and calyces is clearly demonstrated, likewise the reduction in the kidney parenchyma.

Gastro-intestinal symptoms are usually present in every case to some degree. Nausea, vomiting, flatulence, and meteorism are frequently observed. Transitory or persistent hiccoughing may occur. There may be pronounced distention of the abdominal walls. These symptoms are manifestations of a reflex stimulation of the sympathetic nerves (splanchnics) which is due to an irritation of the posterior peritoneum or pressure upon the abdominal viscera by the extravasated fluid in the perirenal tissue.

It is a well established fact that following any injury to the kidney parenchyma or pelvis, there may develop a diminution in the quantity of urine secreted. There may develop a complete cessation of urine through not only the injured kidney but also through the uninjured kidney as a result of a reflex or mechanical anuria. The anuria is, however, of short duration as secretion is usually

Fig. 3. Case 2. Pyelogram taken in 1928. The pelvis and ureter of the upper rudimentary segment of the left double kidney have been filled with sodium iodide (13.5 per cent). The large branched calculus occupying the pelvis of the lower segment of the left kidney is clearly shown. The round shadow in the region of the upper pole of the right kidney is a calculus. A pyelogram of the right kidney, which was taken several weeks later, showed a moderate dilatation of the pelvis and the calculus in the terminal portion of the upper major calyx. Further pyelographic studies of the left double kidney showed a large pyonephrosis of the lower segment but the roentgenograms were too faint for photographic reproduction.

resumed as soon as the initial shock wears off. In cases of ruptured pelvis, the fact that urine is not obtained from the injured kidney may be incorrectly attributed to anuria, whereas the kidney may still retain its secretory function and urine, instead of passing down the ureter, extravasates in the perirenal tissues, and occasionally in the peritoneal cavity or bowel (Wesson, Mathe). A true unilateral anuria on the affected side may develop as a result of the pressure effect of the perirenal extravasation upon the renal pedicle.

Such urinary symptoms as urgency, frequency, dysuria, and tenesmus are uncommon. The occurrence of these symptoms would tend to indicate the presence of an associated obstructive lesion at the bladder neck or a secondary inflammatory lesion in the bladder. Hæmaturia is conspicuous by its absence in cases in which the rupture is strictly confined to the pelvis in contradistinction to rupture of the parenchyma in which instance it is a very important diagnostic sign. If the rupture of pelvis is due to trauma and there is a minute intrarenal parenchymal tear or a rupture of a small intrarenal blood vessel in or near the pelvis, i.e., small blood vessel in the pyramids, hæmaturia may occur at the time of a rupture but soon clears up. The urinary findings are most commonly those associated with an acute progressive toxæmia, i.e., a trace of albumin, an occasional red or white blood cell and casts.

DIAGNOSIS

The diagnosis of ruptured pelvis is always difficult. A review of the literature reveals the fact that the majority of the reported cases remained undiagnosed until the time of operation or at autopsy due to the rarity of the condition and the uncertainty of the clinical signs and symptoms. In those few cases in which a correct pre-operative diagnosis was made, it was necessary to resort to other diagnostic measures, i.e., cystoscopy and pyelography, to establish the diagnosis.

A careful history in every case may be of inestimable assistance in directing the examiner to the possible existence of such a lesion. An antecedent history of renal colic due to stone in the ureter or pelvis is of definite significance, particularly in cases of rupture secondary to calculus obstruction of the ureter. The knowledge of the presence of an inflammatory or obstructive lesion in the upper ureter or pelvis secondary to a stone or stricture in the upper urinary tract in a patient who complains of a sudden severe pain in the renal region and presents a palpable tender mass with muscular rigidity and spasticity over the affected area, accompanied by chills, fever, nausea and vomiting, and rapidly followed by signs of collapse or a severe toxæmia, should cause the examiner to suspect a rupture of the pelvis, though actually the diagnosis must be confirmed by pyelographic study or operation. It may even be impossible to establish the diagnosis when cystoscopy and pyelography are undertaken inasmuch as the offending calculus may totally occlude the ureter or ureteropelvic junction rendering it impossible to pass a ureteral catheter or inject a pyelographic medium beyond the obstruction.

Cystoscopy with bilateral ureteral catheterization has proved to be one of the most valuable diagnostic procedures available. Cystoscopic examination is often undertaken in the hope of relieving an acute renal infection or a ureteral

block with acute retention of urine in the pelvis and the true nature of the upper urinary tract lesion is then disclosed. When the catheter fails to reach the kidney pelvis due to an obstructing ureteral calculus, the urologist may be misled into believing that the calculus is the sole lesion producing the symptoms and may overlook the more serious lesion in the kidney pelvis. Thus, the correct diagnosis of pelvic rupture with perirenal extravasation is undetermined or discovered later at operation or autopsy. If the catheter can be passed into the kidney pelvis or zone of extravasation, clear urine or actual pus may be obtained which should make the urologist suspicious of a pelvic rupture. The rate and amount of urine flowing from the catheter on the affected side should be carefully observed. A large amount of urine aspirated from the perirenal space through the pelvic tear is a presumptive diagnostic sign of ruptured pelvis. In some cases, the urologist is tempted to and does leave the catheter in the pelvis for several days in the hope that drainage of the infected area will result in a subsidence of fever and sepsis and postpones pyelography and operation until a later date with serious consequences.

Differential renal functional tests (phenolsulphonphthalein, indigo carmine, methylene blue, etc.) are of little value in establishing the diagnosis of ruptured pelvis or in determining the function of the injured kidney. The same may be said of the value of blood urea, non-protein nitrogen, etc. As a result of a pelvic tear or perforation, the urine escapes into the perirenal tissues and very little passes down the ureter, with a consequent inaccurate determination of renal function. The result of these tests may show a complete loss of function in the affected kidney which may only be temporary if the rupture occurs in a congenitally normal kidney and permanent if the rupture occurs in a diseased kidney.

There appears to be a divergence of opinion as to the wisdom of employing pyelography in the diagnosis of injuries to the kidney parenchyma and pelvis. Luckett and Friedman strongly urged its use in the diagnosis of kidney injuries. They pointed out that the location and extent of kidney injury could be determined by the dissemination of the pyelographic medium within the kidney substance or outside the confines of the kidney pelvis or capsule. They also emphasized the fact that from the pyelographic findings it is possible to determine whether surgical interference is necessary without waiting for secondary symptoms or complications as an indication for such

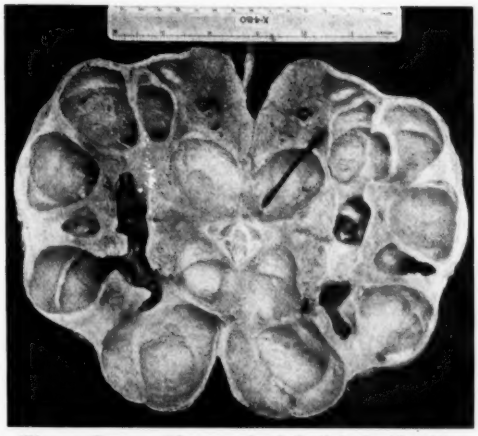

Fig. 4. Case 2. Photograph of the left double kidney removed at autopsy. The arrow points to the perforation in the posterior aspect of pelvis of the lower segment. The large branched calculus occluding the intrarenal portion of the lower pelvis can be seen. The lower kidney segment shows the typical changes of a large multilocular pyonephrosis. The upper rudimentary segment is seen beneath the scale and shows relatively little change in the parenchyma. The small pelvis in the upper segment and a portion of partially duplicated ureters may also be seen.

interference. Beach maintained that pyelography is a harmless procedure and should be employed immediately in every case of suspected kidney injury. Herman and Wallenstein emphasized its value in the diagnosis of ruptured hydronephrosis and Geisinger stressed its importance in the diagnosis of extravasation from the ureter.

It is quite obvious that pyelography should never be attempted in those patients who are critically ill or in shock. In the past, the objection to pyelography was based on the supposed danger attending the injection of an irritating pyelographic medium, i.e., sodium iodide, into an injured kidney or into the perirenal tissues. Fritz and Geisinger maintain that the distribution of a small amount of sodium mercuric iodide into the tissues already infiltrated with pus and urine is not likely to be productive of any serious sequelæ particularly if very low pressure (gravity method) is used in injecting the pyelographic medium. The danger of injecting an irritating electrolyte (sodium iodide) into the perirenal tissues can be readily obviated by employing 15 per cent skiodan, which is non-toxic, non-irritating and non-hæmolytic. Hartman and Kindall have pointed out that the usual criteria, i.e., pain and volume of pyelographic medium injected are usually insufficient to judge overdistention in a traumatized kidney where the

Fig. 5. Case 3. A pre-operative ureteropyelogram showing the marked dilatation of the left kidney pelvis with an obstruction at the ureteropelvic junction.

normal defense mechanism is impaired or destroyed.

The information to be gained by detecting the presence of extension of a varying amount of pyelographic medium beyond the confines of the upper ureter or pelvis is of extreme importance in establishing the diagnosis of a rupture of the pelvis. This procedure was successfully employed in the diagnosis of 16 cases. In 2 cases (Wesson and Turner), demonstration of the pelvic rupture was made by injecting the fistulous tract with an opaque medium. In the case reported by Wesson (Dr. R. V. Day's patient) the pyelographic medium could be seen passing into the bowel. In 2 of the 3 cases reported by the author, the diagnosis was confirmed by a pyelographic study, and in neither instance was there any unpleasant or deleterious effects observed following this procedure. On the contrary, the invaluable assistance rendered by the pyelographic studies in establishing the correct diagnosis and instituting prompt surgical treatment certainly justifies its employment.

Wesson's method of pyelography is the ideal procedure to be employed in chronic obstructive inflammatory lesions of the kidney in order to obviate the danger of a pelvic or parenchymal rupture following syringe pressure pyelography. Wesson's technique consists of: (a) the passage into the renal pelvis of a ureteral catheter the end of which has been plugged with a phonograph needle (or round toothpick) and (b) intravenous injection of neoiopax or neoskiodan. If the pictures obtained by this method are unsatisfactory, retrograde pyelography using the gravity method of low pressure may be resorted to.

The introduction of excretion urography offers a harmless but efficient roentgenological procedure for the diagnosis of kidney injuries. This procedure is not attended by any untoward symptoms or complications. The information to be gained is directly dependent upon the ability of the affected kidney to excrete the dye. It is at once apparent that if a ruptured kidney has been previously damaged by an obstructive or infectious process to the extent that the secretory power of the kidney has been reduced or completely destroyed, intravenous urography will be of no diagnostic assistance. In cases of traumatic or spontaneous rupture of the kidney pelvis, if this method is employed, traces of the dye will be seen outside of the normal confines of the pelvis, which is an important diagnostic sign of extravasation. So far as we have been able to ascertain from a review of the literature, this procedure has not been employed in the diagnosis of ruptured pelvis in any of the reported cases.

A careful roentgenogram of the genito-urinary tract should always be taken in every case, as it may reveal the shadow of a calculus in the ureteral or renal area on the affected side and help to rule out an intra-abdominal lesion. While pyelography is contra-indicated in critically ill or shocked patients, there is no valid objection to obtaining a plain roentgenogram especially where a portable X-ray apparatus is available. Furthermore, in the latter group of patients, it is usually safe to pass an opaque ureteral catheter in order that the exact location of the calculus may be determined. A plain roentgenogram may also show one or more of the characteristic changes associated with perirenal abscess; namely, (1) obscuration of outline of kidney; (2) obscuration of the psoas muscle outline; (3) deviation of the lumbar spine away from the affected side; (4) partial or complete obliteration of the shadows of the lower ribs and the transverse processes of the lumbar vertebræ; (5) alterations in the outline of the diaphragm on the affected side. It is interesting to note that, in a case reported by Wesson, the fistulous connection between the pelvis and the descending colon was demonstrated by means of a barium enema.

DIFFERENTIAL DIAGNOSIS

The conditions with which ruptured pelvis are most likely and most frequently confused are either intrinsic lesions of the kidney (rupture of

the parenchyma, acute hydronephrosis or pyonephrosis, renal neoplasm, etc.) or perirenal lesions (perirenal abscess, perinephritis and retroperitoneal tumor). The most common and most important condition which must be differentiated is a rupture of the kidney parenchyma. In the parenchymal type of rupture the most prominent operative or postmortem finding is the presence of blood in the perirenal tissues. Shock and collapse are usually present to a severe degree and are important clinical features of this type of rupture. In both the spontaneous or traumatic types of parenchymal rupture, especially in the latter instance, hæmaturia is very often a prominent symptom whereas it is usually absent in cases of ruptured pelvis. The spontaneous type of parenchymal rupture is more often associated with nephritis, tuberculosis, polycystic degeneration, asbcess formation, tumor, infarct, aneurism or hæmophilia and results in the extravasation of blood into the surrounding tissues or into the renal pelvis.

The history of previous attacks of renal colic, lumbar pain, hæmaturia, etc., should direct attention to an acute hydronephrosis due to calculous obstruction of the ureter or pelvis or to a pyonephrosis. The history of an antecedent cutaneous infection, i.e., boil, furuncle, felon, etc., is of great aid in pointing the way to a correct diagnosis in those cases of perinephritic abscess or perinephritis not due to a ruptured pelvis. The presence of staphylococci in the urine may also help to establish the diagnosis of the hæmatogenous type of perirenal abscess. A plain roentgenogram may show the typical findings associated with perirenal abscess, i.e., obliteration of the renal shadow, the psoas muscle outlines, and the transverse processes, but a pyelogram will show an intact pelvis which should rule out a rupture of that organ. The absence of symptoms of collapse or severe toxæmia in these cases should serve to differentiate these two conditions from ruptured pelvis.

The presence of shock or collapse may lead to confusion in differentiating this condition from intra-abdominal lesions, i.e., rupture of an abdominal viscera, perforation of a gastric or duodenal ulcer, acute pancreatitis (Bretanno), etc. The presence of jaundice, acute pain in upper right quadrant, localized tenderness and muscle spasm in the same area accompanied by nausea, and vomiting are strongly suggestive of acute cholecystitis or cholelithiasis. The picture may be further complicated by the diffuse or generalized abdominal pain accompanying intra-abdominal lesions despite the fact that generalization of pain is an infrequent symptom in cases of ruptured pelvis. At times it

Fig. 6. Case 3. Ureteropyelogram taken prior to nephrectomy. The extravasation of the dye into the perirenal tissues has produced a blotchy shadow about the renal pelvis. The abrupt ending of the ureteral outline at the ureteropelvic junction indicates an obstruction at this point. The psoas outline on the left side is obliterated but there is no deviation of the spine.

is extremely difficult or even impossible to exclude a coincident intra-abdominal injury occurring at the time of the pelvic rupture, especially in those cases of spontaneous perforation of the peritoneum with peritonitis and in the traumatic type of pelvic rupture where the etiological factor is external force directed against the abdomen or loin. In fact the presenting symptoms may be so strongly suggestive of an intra-abdominal injury that an exploratory laparotomy is performed revealing the true underlying renal lesion which is then approached through a lumbar incision. Two cases (Nabielek, Kapel) were diagnosed as an acute appendicitis and laparotomy revealed the true nature of the lesion. In the 2 other cases of peritonitis secondary to a pelvic rupture (Nabielek and Hammel), a pre-operative diagnosis of ruptured calculous pyonephrosis with perforation of the peritoneum and peritonitis was made.

PROGNOSIS

Since the chief danger in cases of ruptured pelvis lies in the extravasation of urine and the subsequent development of a devastating phlegmonous or gangrenous infection in the perirenal tissues and finally septicæmia, it naturally follows that the prognosis varies directly with the time and type of treatment employed. It is generally accepted that extravasation of urine, regardless of location, source or cause, is a serious surgical con-

dition demanding prompt and efficient treatment. Immediate incision and drainage of the perirenal tissues is imperative and, in fact, may even be life-saving in effect. After preliminary drainage has been established, the true nature of the condition or the underlying cause can be determined later or not as circumstances dictate.

Death may occur as a result of this severe infection, toxæmia, or septicæmia. If the patient survives the initial stage complications may ensue, viz., the perforation of the perirenal abscess into the peritoneum, abdominal viscera or through the diaphragm, and the patient succumbs after a protracted period of wasting and suffering. The presence of an associated intra-abdominal lesion or a peritoneal tear occurring at the time of the pelvic injury offers a most unfavorable prognosis. The presence of a disease process in the opposite uninjured kidney may seriously endanger the patient's life inasmuch as the injured kidney in most instances is damaged beyond repair and the entire secretory burden is thrust upon an impaired organ. As far as we have been able to ascertain, there are no cases reported in which a simultaneous bilateral rupture of the kidney pelvis occurred with the exception of Campbell's two cases: chemical necrosis following the intrapelvic injection of sodium hydroxide and bilateral avulsion of pelvis following a fall. Such an accident would almost certainly lead to an early demise.

According to Morris, the prognosis in cases of rupture of the renal parenchyma, renal pelvis or ureter is less favorable than in rupture of any abdominal viscera. This pessimistic attitude may be attributed to the fact that the high mortality figures associated with rupture of any portion of the kidney in the past were based on the reports of isolated cases or series of grave cases. However, the recent refinements in urological and roentgenological diagnosis and the improvement in surgical technique have been responsible for a marked reduction of the mortality and morbidity of this condition. In the series of cases collected by the author the immediate operative mortality was 6 per cent (3 deaths in 50 operative cases), which is a very modest figure when one considers that they include cases in which preliminary drainage was delayed intentionally or non-intentionally by the patient or the surgeon.

CASE REPORTS

CASE 1. N. M., a man 77 years of age, an inmate of the Aged Home, was admitted to the hospital on May 6, 1932, with the complaint of pain in his left kidney region. He had had a bilateral ligation of the vas deferens and a perineal prostatectomy 1 year previously with an excellent functional result. Four weeks before admission to the hospital the patient developed a sudden sharp pain in his left lumbar region radiating to the groin. The pain persisted for several hours and was accompanied by nausea, vomiting and fever. A dull pain persisted in the left lumbar region and left upper quadrant after the first attack. The patient gave a history of nocturia (2 to 3 times), burning, hesitancy, and urgency, but no history of passing a calculus or hæmaturia or trauma.

Physical examination was negative except for definite fulness in the left upper quadrant extending from the left flank to the mid-epigastrium. A mass about the size of a large orange was felt and appeared to be smooth and tender to touch. There was no ballottement or fluctuation. There was tenderness in the left costovertebral angle. The leucocyte count was 10,000 with 86 per cent polymorphonuclears. The urine showed 20 to 30 pus cells per high power field.

Following admission to the hospital, the temperature remained slightly elevated for 4 days. Cystoscopy and pyelography were then performed. Two small calculi in the bladder were seen and removed by a rongeur. Pyelogram of the left kidney showed extravasation of dye around the pelvis of the kidney. The pelvis and calyces appeared to be dilated. A tentative diagnosis of a left pyonephrosis with a perinephritic abscess due to rupture of the pelvis was made. He was kept under observation for several days but as he continued to show a slight daily elevation in temperature and the mass appeared to be increasing in size and became more tender on palpation, operative intervention was decided upon. Fourteen days after his admission to the hospital a subcapsular nephrectomy was performed under spinal anæsthesia. The abscess contained approximately 3 ounces of a thick, green, foul-smelling pus which was found on the posterior aspect of the lower pole of the kidney and extended around anteriorly to the region of the pelvis. Two perforations were noted in the region of the ureteropelvic junction. Culture of the pus from the abscess revealed Bacillus pyocyaneus. The patient had a stormy convalescence for the first few weeks after operation. The wound broke down and the patient developed furuncles in the left lumbar region culminating in a fairly large carbuncle, which responded slowly to treatment. He was discharged from the hospital 34 days after operation in good condition with the wound entirely healed except for a small sinus tract which healed 2 weeks later.

Pathological examination showed the usual changes of arteriosclerosis and pyonephrosis. The ureter was constricted at the ureteropelvic junction. Above this point of constriction, there was a small perforation 3 millimeters in diameter and 2 millimeters in diameter, respectively.

It is difficult to determine the etiological factor responsible for the perforations of the pelvis and ureter in this case. It is the author's opinion that the essential pathological changes present in the affected kidney, i.e., pyonephrosis, pyelonephritis, and stricture of the ureteropelvic junction, were secondary to the benign prostatic enlargement which was removed 1 year before. The perforations in the pelvis were probably the result of increased back pressure beyond the stricture at the ureteropelvic junction. It is difficult to explain the development of the perforations below the ureteropelvic junction unless these perforations are the result of an attempt of extravasated urine and pus to drain back into the ureter.

CASE 2. K. Z., 53 years of age, a housewife, was admitted to the hospital on June 22, 1933, with the complaint of pain in the left upper quadrant. The patient gave a history of kidney colic on the right side in 1926. She subsequently developed kidney colic on the left side in 1928. In March, 1928, a right nephrolithotomy was performed. At this time pyelographic studies also revealed a large calculus present in the lower and larger half of a double kidney on the left side. There was an incomplete duplication of the ureter on the left side with bifurcation at the middle and upper third of the ureter. Operative removal of the left renal calculus was deemed inadvisable because of the marked infection present in both kidneys and the reduced renal function in each kidney. From 1926 to 1933 she received about 75 cystoscopic treatments in the form of bilateral ureteral dilatations and pelvic lavages at intervals of 2 to 4 weeks.

For 2 weeks previous to admission the patient had been confined to bed because of marked weakness and severe pain in the left upper quadrant. She also complained of chills, fever, nausea and vomiting. The urine had been very cloudy and at times blood tinged. The patient complained of frequency every hour during the day, and nocturia 1 to 3 times, burning on urination, urgency, and tenesmus. She noticed a swelling of the left upper quadrant for the previous 2 weeks, which gradually increased in size. She was also troubled with abdominal distention, flatulence, eructation, and constipation.

On examination the patient appeared to be acutely ill and very toxic. There were no evidences of shock or collapse. Cardiac findings were those of mitral insufficiency and arteriosclerotic heart disease. There was a swelling in the left upper quadrant with spasticity and rigidity of the overlying muscles. It was impossible to outline a definite mass in this area. There was exquisite tenderness in the left upper quadrant, left loin, and left lumbar region.

The urine gave a strongly positive test for albumin and microscopically showed a large number of pus cells, an occasional red blood cell, granular casts and organisms which proved to be Bacillus coli. The leucocyte count was 9,400 and 78 per cent polymorphonuclears. The blood urea was 70.70 milligrams per cent. Intravenous phthalein was reported as 10 per cent for the first hour and 15 per cent for the second hour.

A diagnosis was made of an acute exacerbation of a calculous pyonephrosis involving the lower half of the left double kidney. The signs and symptoms pointed to the presence of an accompanying perinephritic abscess on the left side. Due to the fact that the patient appeared to be critically ill, cystoscopic and pyelographic studies were not carried out. Immediate operation was advised upon admission to the hospital, but the family refused permission until 10 days after admission when the patient appeared to be moribund. She was given a pre-operative transfusion of 500 cubic centimeters of citrated blood. Ten days after admission to the hospital an exploratory lumbar incision was made under spinal anæsthesia and a large perinephritic abscess was found surrounding the entire kidney and containing about 3 quarts of a thick, greenish pus which on culture was reported as Bacillus coli. The abscess extended up to the diaphragm and down to the pelvic brim, but had not broken its way through the overlying muscles. Extensive drainage of the abscess area was provided. Due to the poor condition of the patient, it was decided not to explore the kidney or to attempt to remove the kidney. Following the operation, the patient appeared to rally somewhat, but on the third postoperative day became stuporous and semicomatose and died the following morning.

A partial autopsy was performed which disclosed a double kidney on the left side with an incomplete duplication of the ureter. The upper supernumerary segment of the double kidney appeared to be relatively normal on gross examination and cross section. The lower segment was a massive multilocular pyonephrosis. The pelvis of the lower segment was covered with a large amount of fibrolipomatous tissue which was diffusely inflamed At a point on the posterior surface of the pelvis corresponding to the mid-portion of the lower segment there was found a perforation from which thick greenish pus exuded. On cross section of the lower segment there was a large branched calculus occupying the extrarenal portion of the pelvis of this segment. There was an area of necrosis about the perforation. The right kidney was of the hypoplastic type and showed arteriosclerotic changes.

The etiological factor responsible for the perirenal suppuration was a perforation of the chronic inflamed pelvis by a large irregular calculus. In our review of the literature we have not found a similar case of perforation of the wall of the pelvis of one segment of a double kidney. Undoubtedly, the prognosis in this case would have been more favorable if drainage of the abscess had been instituted immediately. The lack of co-operation on the part of the patient's family in consenting to an operation also contributed considerably to the fatal outcome in this case.

CASE 3. J. P., 53 years of age, married, male, merchant, was admitted to the hospital on May 28, 1932, with the complaint of pain in the left abdomen. The past history was negative except for a chronic gastro-intestinal complaint for the previous 10 years in the form of attacks of cramp-like pain in the left lower quadrant. The patient was admitted to the hospital for a thorough study and during the course of the examination was found to have some pus and red blood cells in his urine. He gave a history of occasional diurnal frequency every 1 to 1½ hours, and nocturia, 1 to 2 times, hesitancy and occasional burning on urination. There was no history of hæmaturia or renal colic.

Physical examination was essentially negative except for a slight tenderness in the left upper quadrant over the left kidney. A positive left ureteral point was present. The prostate was of normal size.

A complete urological study was undertaken and disclosed: (1) median bar formation; and (2) left hydronephrosis, third degree, infected and non-functioning. A plastic operation on the pelvis of the left kidney was performed under spinal anæsthesia. An elliptical piece of tissue was removed from the superior and inferior aspects of the pelvis and a Heinecke-Mikulicz repair was done at the ureteropelvic junction. The patient made an uneventful recovery. About 1 month after operation a cystoscopic and pyelographic study was made and revealed a marked reduction in the size of the left hydronephrosis with a definite restoration of function in this kidney.

Eighty days after operation he developed a sudden pain in his left loin followed by a chill, nausea, vomiting and fever. Some relief was obtained by an application of heat to his left loin. Four days later he had another chill and was seen for the first time following the operation. At this time an area of fluctuation was noticed in the upper angle of his incision. There was tenderness in this area. There was no history of trauma. A tentative diagnosis of rupture of the pelvis with extravasation of urine was made and the patient was sent into the hospital.

Pyelographic examination revealed dilatation of the left pelvis with an extravasation of dye outside the kidney pelvis. Ninety-three days after the previous plastic operation on the pelvis, incision and drainage was performed at the site of the old sinus tract and 50 cubic centimeters of a foul-smelling sero-sanguinous material escaped. Three days later a left nephrectomy was performed under spinal anæsthesia. The patient made an uneventful recovery and was discharged from the hospital with the wound entirely healed.

Examination of the left kidney showed diffuse pyelonephritic involvement of the kidney substance with a diffuse cortical abscess formation, also a marked perinephritis was present. At the ureteropelvic junction, which was the site of the Heinecke-Mikulicz repair, there was a very marked narrowing of the mucosa, producing almost complete obstruction. There was a perforation in the line of the suture.

The cause of the perirenal extravasation of urine in this case was the failure of the suture line to hold following plastic repair of the stricture at the ureteropelvic junction and the development of a postoperative stricture and subsequent perforation at this point. Obviously, the suture line held for a short time after operation for a pyelographic study performed 35 days after operation showed no extravasation of dye. However, it is possible that the suture line was weakened as a result of the postoperative pyelographic study undertaken to check the result of the operation. Intravenous urography for this purpose should preferably have been employed.

TREATMENT

The keynote of success in the treatment of rupture or perforation of the kidney pelvis is immediate operative intervention. The type of operative treatment may be either conservative or radical since no hard or fast rules can be laid down to apply to every case. There are several factors which require careful consideration and which may greatly influence the surgeon in his choice of operative therapy. These factors are: (1) the early recognition of the true nature of the disease; (2) the general condition of the patient; (3) the time elapsing between the pelvic rupture and the diagnosis of the condition and institution of operative treatment; and (4) determination of the pathological condition of affected kidney and condition of the opposite kidney. If the patient has been under observation for some time due to the uncertainty of the diagnosis or to the failure of the physician to recognize the serious nature of the condition, the operative treatment may vary depending upon the secondary pathological complications developing in the course of the disease. The final decision as to the type of operative therapy must be reserved until the time of operation as a very careful and rational pre-operative plan of therapy may be disorganized by the pathological findings encountered at operation, i.e., extent of extravasation of urine and suppuration in the perirenal tissues, and the presence of a severe disease process in the damaged kidney.

The most important step in the surgical treatment of ruptured pelvis is prompt and adequate drainage of the extravasated urine or pus in the perirenal tissues. This procedure is a veritable life-saving measure as it assures proper elimination of urine and pus from the perirenal tissues, relieves the patient of toxic absorption of urine, fibrin and tissue ferments, enables the patient to regain strength and recover from shock. All other steps in the operative treatment can be postponed or delayed, if necessary, without jeopardizing the life of the patient.

Occasionally, the immediate institution of the drainage of the perirenal tissues is sufficient to effect a cure. It is conceivable that such a favorable outcome may be obtained in the case of a traumatic rupture of the pelvis of a congenitally normal kidney in which the perirenal extravasation of urine is handled efficiently. In such a case, perirenal suppuration is absent or very slight and clears up entirely and the pelvic fistula closes spontaneously. It is very important that the surgeon should expose the entire kidney, if possible, and make a careful examination of the kidney in order that any additional tears or rupture in the renal parenchyma, pelvis, vascular pedicle and posterior peritoneum are not overlooked or neglected.

The ideal conservative form of treatment combines incision and drainage of the perirenal tissues with repair of the rupture or perforation in the pelvis and correction of the pathological process responsible for the rupture. While this plan of treatment is in keeping with the trend of modern renal surgery toward the conservation of the kidney, it is not always possible or advisable to adhere to this type of treatment. In reality there are relatively few cases of ruptured pelvis that lend themselves to such conservative operative therapy. This procedure was employed in 2 cases (Rowland, Cowden). In the majority of instances, the extravasation of urine has proceeded on to frank suppuration and the kidney shows signs of severe damage, so that any attempt to save the kidney in the presence of a severe suppurative process in the kidney and surrounding tissues may jeopardize the patient's life or prolong the convalescence unnecessarily. However, there is a small percentage of cases in which this type of conservative treatment is recommended and urged. When the patient is operated upon within

a few hours after a rupture of either the spontaneous or traumatic type and the kidney does not appear to be badly damaged by a pre-existing pathological process, and the extravasation of urine is scant and well localized, conservative treatment is indicated and yields good results. This type of treatment is particularly applicable to those cases with small lacerations or perforations secondary to an impacted calculus in the pelvis or upper third of the ureter in which the removal of the obstructing calculus, repair of the pelvic laceration and drainage of the renal bed can be quickly and efficiently accomplished. This type of treatment was successfully employed in 7 cases (Legueu, Mathe and Ovideo, Turner, Beach, Crane, Mathe, and Wesson). In removing the offending calculus it may be necessary to enlarge the site of rupture or perforation and convert it into a pyelotomy incision which can readily be closed by suturing.

While it may seem to be a logical and ideal procedure to attempt a plastic repair of pelvic laceration at the time of preliminary drainage such a procedure is always difficult and frequently impossible in the presence of an inflammatory and infiltrating process in the perirenal tissues or dense peripelvic adhesions resulting from the extravasation of urine and pus. Experience has shown that the success of plastic operation on the renal pelvis depends upon careful planning and aseptic operative conditions. Furthermore, it is folly to attempt a plastic operation on the pelvis without a previous determination of the condition of the kidney or ureter on the affected side either before or at the time of operation since it is difficult to conceive how any form of repair can be expected to hold under pressure proximal to an unrecognized ureteral obstruction.

The radical type of treatment in cases of ruptured pelvis is combined removal of affected kidney and drainage of perirenal tissues, provided the opposite kidney is normal. This type of treatment was employed in 14 cases without a death. Inasmuch as the kidney presenting a pelvic rupture is practically always considerably damaged or totally destroyed by back pressure (hydronephrotic atrophy secondary to calculous obstruction) or suppurative processes (pyelonephritis), nephrectomy assures the removal of the focus of infection and the elimination of the cause of extravasation of urine and pus into the perirenal tissues and the development of unpleasant and serious sequelæ can be avoided. In the final analysis this form of treatment may prove to be most conservative from the standpoint of saving the life of the patient, preventing postoperative complications and shortening the period of convalescence. Not only is nephrectomy indicated in those cases of pelvic rupture in which the kidney is destroyed by back pressure or a chronic inflammatory and suppurative process but also in those cases in which the pelvic rupture is accompanied by an associated injury to the vascular pedicle or an extensive and severe laceration of the parenchyma. Nephrectomy should also be performed in those cases in which there is an extensive rent in the pelvis that cannot be sutured as in the case of a large hydronephrosis; or the pelvis has been avulsed from its attachments at the hilum; or the ureter has been completely torn across at the ureteropelvic junction and repair is difficult due to peripelvic inflammation.

Mathe has stressed the importance of performing a two-stage operation consisting of preliminary incision and drainage followed by secondary nephrectomy at a later date in the advanced cases presenting signs of shock, collapse or severe toxæmia. This type of treatment was employed in 10 cases without a death. The exercising of such judgment often is the determining factor in obtaining both a live patient and a good functional result. As many of the patients with ruptured pelvis appear to be debilitated and toxic from the accompanying perirenal suppuration, it is readily understood why primary nephrectomy under these conditions is fraught with danger and likely to terminate fatally. Primary incision and drainage serves to control and minimize the danger of the perirenal suppuration and enables the patient to recover before a secondary operation, either nephrectomy or conservative repair, is undertaken. Furthermore, the urologist may take advantage of the period of convalescence following preliminary incision and drainage to undertake a thorough urological study to determine the cause of the pelvic rupture and plan the operative procedure necessary to correct or remove the causative lesion. In the very sick patients, it is important that the preliminary incision and drainage be done with as little manipulation as possible in order to preserve the natural barriers and to avoid dissemination of the infection.

The choice of the secondary operative procedure to be performed depends upon a variety of possible circumstances which make generalizations impractical. As indicated above, in an occasional case the perirenal suppurative process may clear up entirely and the pelvic fistula may close spontaneously thus eliminating the necessity of a secondary operation. In those cases in which the integrity of the pelvis, or the continuity of the ureter or pelvis has been interrupted by partial or

complete circular laceration, cicatricial stenosis, or destructive process, the pelvic fistula may persist and a conservative plastic operation on the renal pelvis may suffice to effect a cure. However, it is very likely that even under these favorable circumstances, the destructive process in the affected kidney has impaired the kidney function to such an extent that the improvement in the function of the affected kidney following plastic operation is so slight that infection or stasis soon ensue, necessitating subsequent nephrectomy.

Obviously in those cases in which evidence of bilateral renal disease has been previously determined, preliminary incision and drainage is indicated pending a more complete investigation of both kidneys. This type of treatment was employed in 2 of 3 fatal cases which were moribund at the time of operation. In cases of ruptured pelvis complicated by bilateral renal insufficiency or bilateral hydronephrosis, temporary pyelostomy or nephrostomy or decapsulation at the time of preliminary incision and drainage may be an extremely valuable measure and may preserve the function of the kidney until some final corrective procedure is carried out.

Occasionally the presenting symptoms may be so strongly suggestive of an intra-abdominal lesion that an exploratory laparotomy to rule out such a lesion was performed (Dodge, Rowland, McAlpine, Hammel) before exposing the kidney through the usual lumbar incision. It is well to point out that infrequently the ruptured pelvis, especially in the spontaneous type, may be accompanied by a peritoneal perforation with peritonitis and it may be advantageous to approach or remove the kidney by the transperitoneal route and at the same time provide drainage of the perirenal tissue through a stab incision in the loin.

The question of anæsthesia is an important one. When preliminary incision and drainage is performed in patients who are critically ill or moribund, the operation should be done under local infiltration anæsthesia. If the patient's general condition is good and symptoms of shock or toxæmia are absent, spinal anæsthesia, using 50 to 100 milligrams novocain may be employed with safety as in 2 of the author's cases. Inhalation narcosis with ether, whose cardiac stimulative powers are well known, should be employed in those cases presenting threatening signs of vascular collapse or showing a low cardiac reserve.

CONCLUSIONS

A review of 64 cases of ruptured pelvis collected from the literature, and the author's experience with 3 personal cases warrants the following conclusions:

1. Rupture of the kidney pelvis proper is a relatively rare condition. The rupture may be of the traumatic or spontaneous (non-traumatic) type.

2. The traumatic type of ruptured pelvis may occur in a congenitally normal kidney or in an acquired inflammatory (chronic pyelonephritic) or obstructive (hydronephrotic) kidney. The rupture is usually the result of direct or indirect trauma exerted against the kidney in such a manner that the physiologically or pathologically distended or chronic inflamed pelvis is jammed against the lower ribs or the transverse processes of the upper lumbar vertebræ as maintained by Kuster. The rupture is usually linear and radial in character. The degree of external violence varies from a crushing injury to an indirect blow in cases of rupture of a hydronephrotic pelvis.

3. The spontaneous type of pelvic rupture practically always occurs in a kidney which is the seat of a chronic pyelonephritic process or whose pelvis is dilated as the result of a ureteral or pelvic obstruction. The most common type of spontaneous rupture is the rupture of the pelvis of a hydronephrotic kidney secondary to an obstruction of the ureter or pelvis by a calculus or stricture. The rupture occurs as the result of a sudden or gradual alteration in the increased back pressure caused by an obstructive lesion in the upper or lower urinary tract. Perforation of the pelvis resulting from pressure necrosis of an impacted calculus is another frequent type of spontaneous rupture.

4. Rupture of a pathologically weakened pelvis may also occur as the result of instrumental perforation or follow the exertion of increased pressure in the syringe method of pyelography. In rare instances, perforation may be due to chemical necrosis following the injection of a strong alkali by mistake during pyelography or renal lavage.

5. The traumatic type of rupture has a greater incidence than the spontaneous type. The traumatic type apparently occurs with greater frequency among the males which may be due to the fact that males are subjected to greater hazards in this age of highly mechanical industries, automotive travel, and competitive sports. The spontaneous type occurs with about equal frequency in both sexes. The traumatic type may have a greater incidence in children due to increased susceptibility of a pathologically weakened pelvis in children to rupture following mild traumata which may be attributed to the persistence of

infantile ptosis and lack of bony protection of the ribs.

6. There is no definite symptom complex or clinical syndrome that is absolutely typical or constantly associated with rupture of the pelvis. The urologist should suspect a rupture of the pelvis if patient gives an antecedent history of chronic pyelonephritis or hydronephrosis secondary to calculus in the pelvis or ureter and presents the following train of symptoms, viz., sudden sharp pain in renal region followed by sudden or gradual swelling or mass in same area, accompanied by chills, fever, nausea, vomiting, and frequently shock or collapse. Signs of collapse may be present in the traumatic type of rupture but absent in the spontaneous.

7. The clinical impression of ruptured pelvis should always be confirmed or substantiated by a thorough urological study including pyelography since this is the only dependable method of diagnosis. The advantages of the gravity method of pyelography and Wesson's combined method of intravenous urography and ureteral catheterization and the dangers of syringe pressure pyelography cannot be too strongly emphasized. In the extremely toxic and debilitated patients, retrograde pyelography is contra-indicated but intravenous pyelography can be substituted without fear of producing any unpleasant symptoms or complications.

8. Successful treatment in cases of ruptured pelvis is directly dependent upon an early diagnosis and immediate surgical intervention. The ultimate choice of the operative procedure can only be made at time of operation and must take in consideration the general condition of the patient, pathological condition of the kidney as seen at operation, and the extent of the extravasation of urine or the suppurative process in the perirenal space.

9. Treatment may either be conservative or radical. The conservative procedure is essentially incision and drainage and, if possible, correction of pathological processes responsible for the rupture and repair of the pelvic laceration. The radical procedure is nephrectomy provided the opposite kidney is healthy. In the very toxic and debilitated patients treatment should be carried out in two stages, viz., preliminary incision and drainage followed by nephrectomy or conservative repair at a later date.

BIBLIOGRAPHY[1]

I. Traumatic rupture of the kidney pelvis—31 cases

1. HAWKINS, C. Case of aqueous encysted tumor of the kidney. Med. Chir. Tr., 1833, 18: 175—one case.
2. STANLEY, E. An account of two cases of rupture of the ureter or pelvis of the kidney, from external violence followed by large effusion of urine into the abdomen. Med. Chir. Tr., Lond., 1844, 27: 1—one case.
3. CROFT, J. A case of traumatic hydronephrosis. Tr. Clin. Soc., Lond., 1881, 14: 107—one case.
4. MAY, B. Injury to the kidney and obstruction to ureter; retention of urine in loin. Brit. M. J., 1883, 1: 108—one case.
5. MORRIS, H. On the symptoms and treatment of contusions of the kidney. Clin. J., Lond., 1884, 4: 217—one case.
6. JAECKEL. A case of subcutaneous rupture of the kidney. Centralbl. f. Chir., 1891, 18: 431—one case.
7. SNOW, H. Quoted by Kapel—one case.
8. DODGE, G. E. Subcutaneous rupture of the kidney; with a report of nine cases. Ann. Surg., 1902, 36: 899–909—one case.
9. ROWLAND, R. P. Case of ruptured ureter due to trivial injury. Med. Press Circ., Lond., 1909, 87: 404—one case.
10. WILDBOLZ, H. Traumatische Hydronephrose geheilt durch Pyeloneostomie. Ztschr. f. Urol., 1911, 5: 672–677—one case.
11. MARTIN, W. Rupture of the ureter followed by extravasation of urine and suppurative nephritis; nephrectomy. Ann. Surg., 1912, 55: 468—one case.
12. BRETANNO, A. Two cases of ruptured hydronephrosis. Ztschr. f. Urol., 1912; 6: 713—two cases.
13. BAILY, H. Injuries to the kidney and ureter. Brit. J. Surg., 1923, 11: 609—four cases.
14. MCALPINE, J. B. Traumatic rupture of a hydronephrosis. Lancet, 1923, 2: 833—one case.
15. NASH, W. G. Traumatic laceration of a hydronephrosis. Lancet, 1924, 1: 128—one case.
16. WESSON, M. B. The treatment of traumatic rupture of the kidney. Ann. Surg., 1926, 83: 246—two cases.
17. LEGUEU, F. Quoted by Rosenkranz in the discussion of Mathe's article—one case.
18. COWDEN, C. N. Surgical accident (Avulsion of ureter during removal of renal calculus). Tr. South. Surg. Ass., 1928, 41: 344—one case.
19. BEACH, E. W. Traumatic rupture of the kidney; report of ten cases. Calif. & West. Med., 1930, 30: 494—one case. Also reported by Wesson in 1926.
20. OSGOOD, A. T., and CAMPBELL, M. F. Injuries of the kidney. Practice of Surgery, edited by Dean Lewis; Urology: vol. 8, chap. 5. Hagerstown, Md.: W. F. Prior Co., 1928–1930—two cases.
21. SCHMIDT, A. Spontaneous rupture of infected cystic kidney. Ztschr. f. Urol., 1931, 25: 93—one case.
22. MATHE, C. P. Spontaneous rupture of kidney. Tr. Western Branch Soc. Am. Urol. Ass., 1932, 1: 78; Urol. & Cutan. Rev., 1932, 36: 605—one case (Case IV).
23. LAZARUS, J. A. Traumatic rupture of a congenital hydronephrotic kidney. Ann. Surg., 1932, 95: 117—one case.
24. EWELL, G. H. Traumatic rupture of a hydronephrotic kidney. J. Urol., 1933, 29: 685—one case.

II. Spontaneous rupture of the kidney pelvis—26 cases

1. LEGUEU, F. Pyelographie d'une perforation de l'uretère par un calcul lombaire á pointe acérée. Bull. Soc. franç. d'urol., 1926, 5: 214—one case.
2. FUMERY, J. Péritonites d'origine rénale non traumatique, non postopérative. (Louis Arnette); quoted by Kapel—one case.
3. MATHE, C. P., and OVIDEO, G. F. Spontaneous rupture of hydronephrotic sac secondary to ureteral stone. Calif. & West. Med., 1927, 26: 790—one case.

[1]The cases in the first five groups are arranged in chronological order.

4. FRITZ, W. Spontaneous and traumatic ruptures of the pelvis; four cases. Wien. klin. Wchnschr., 1928, 41: 1306—two cases.
5. WALLENSTEIN, S. Urinary extravasation at varying levels; a report of 16 cases. Med. J. & Rec., 1928, 525—one case.
6. TURNER, A. C. Unusual case of urinary fistula. Lancet, 1929, 2: 220—one case.
7. GOTTSTEIN. Perforation paranephritischer Abscesse in die freie Bauchhohle. Zentralbl. f. Chir., 1929, 56: 2536; Peritonitis of renal origin. Ibid., 1930, 57: 1876—one case.
8. BEACH, E. W. Loc. cit., ref. 19, Group I—one case.
9. OSGOOD, A. T., and Campbell, M. F. Loc. cit., ref. 20, Group I—one case.
10. BROWN, R. Spontaneous rupture of the renal pelvis. Surg. Clin. N. America, 1930, 10: 969—one case.
11. GEISINGER, F. J. Extravasation from ureter. Ann. Surg., 1931; 93: 544—one case.
12. ROST, F. Perforation into abdominal cavity of pus from a calculous kidney; case. Ztschr. f. Urol., 1931, 25: 439—one case.
13. NABIELEK. Rare operative findings in the field of kidney surgery. Zentralbl. f. Chir., 1931, 58: 2899—two cases.
14. CRANE, J. J. Extravasation of urine from the ureter, secondary to ureteral calculi. Western Urological Soc., San Francisco, California, 1931; also personal communication—one case.
15. MATHE, C. P. Loc. cit., ref. 22, Group I—three cases (Cases Nos. I, II, V).
16. WESSON, M. B. Rupture of ureter; a medico-legal problem; report of cases. Calif. & West. Med., 1932, 37: 297—one case.
17. HAMMEL, H. Free perforation of pyonephrosis into the abdominal cavity. Deutsche Ztschr. f. Chir., 1932, 236: 155—one case.
18. KAPEL, O. Peritonitis of renal origin. Deutsche Ztschr. f. Chir., 1933, 239: 462—two cases.
19. ABESHOUSE, B. S. Three cases reported herein.

III. Perforation of the pelvis by ureteral instruments—3 cases

1. HUNNER, G. L. Morbidity and surgical procedures following accidents incident to cystoscopic treatment of the ureter. Practice of Surgery, edited by Dean Lewis. Urology, Vol. 8, Chap. II, pp. 52–78. 1928–1930, Hagerstown, Md.: W. F. Prior Co.—three cases (Cases Nos. V, VI, VII).

IV. Rupture of pelvis following pyelography—4 cases

1. HOFFMAN, E. R. Dangers of pyelography. Folia urol. 1914, vol. 7; Ztschr. f. Urol., 1914, 8: 508—one case.
2. HUNNER, G. L. Loc. cit., ref. 1, Group III—one case (Case No. X).
3. OSGOOD, A. T., and CAMPBELL, M. F. Loc. cit., ref. 20, Group I—one case.
4. KINDALL, L. Rupture complications of syringe pressure pyelograms. Urol. & Cutan. Rev., 1933, 37: 711—one case.

V. Fistula formation between the renal pelvis and other organs—12 cases

A. Reno-bronchial fistula

1. DE HAEN. Ratio Med. Par., 1778, 3: 130; quoted by Mertz—one case.
2. RAYER, P. Traité des maladies des reins. pp. 269–293. Paris: J. Bailliere, 1839; Quoted by Mertz and Higgins and Hicken—one case.
3. MATHE, C. P. Loc. cit., ref. 22, Group I. This case is the same as that reported in the series of spontaneous rupture of the pelvis—one case.

B. Reno-colic fistula

1. DICKINSON, W. H. Renal and Urinary Affections. New York: William Wood & Company, 1885—two cases.
2. WATSON, F. S., and CUNNINGHAM, J. F. Subparietal injuries of the kidneys. Diseases and Surgery of the Genito-Urinary System. Vol. 1, pp. 91–123. Philadelphia: Lea and Febiger, 1908; 1: 91–123—one case.
3. FULLER, E. Discussion of paper by Chute, A. L. Two cases of vesico-intestinal fistula due to diverticulitis of the sigmoid. Tr. Am. Ass. Genito-Urin. Surg., 1911, 6: 96—one case.
4. WESSON, M. D. Loc. cit., ref. 16, Group I. This case is the same as that reported in the series of spontaneous ruptures of the pelvis—one case.
5. HIGGINS, C. C., and HICKEN, H. F. Spontaneous renal and ureteral fistulæ. Arch. Surg., 1933, 27: 817—two cases.

C. Reno-duodenal fistula

1. RAYER, P. Loc. cit., ref. A, 2, Group V—one case.
2. DAVIS, E. G. Duodeno-ureteral fistula of spontaneous origin. J. Am. M. Ass., 1918, 70: 376—one case.

VI. General references

1. AGLAVE, M. P. Note sur la situation du rien chez le jeune enfant par rapport a la crête iliaque et réflexions sur l'ectopie rénale. Bull. et. mém. de la Soc. Anat. de Par., 1910, 85: 595.
2. BABITZKI, P. Hydronephrosenruptur und Pseudohydronephrose. Arch. f. klin. Chir., 1912, 97: 993.
3. BISQUERT, L. Rupture of hydronephrotic kidney; operation. Bol. soc. de cir. de Chile., March-April 1928, 6: 2.
4. BOBROFF. Subkutane Nierenrupturen; ein Fall von Nephrectomie nach Nierenruptur. Centralbl. f. Chir., 1892, 19: 721.
5. DELBET, P. De la contusion rénale et de son traitement. Ann. de mal. d. org. genito-urin., 1901, 19: 699.
6. GIBSON, C. L. Rupture of kidney in children. New York State J. Med., 1912, 12: 326; Am. J. Med. Sc., 1912, 163: 649.
7. GRAWITZ. Ueber Nierenverletzungen. Arch. f. klin. Chir., 1908, 83: 547.
8. GUTERBOCK, P. Beitraege zur Lehre von der Nierenverletzungen. Arch. f. klin. Chir., 1896, 51: 225.
9. HARRIGAN, A. H. Rupture of a hydronephrotic kidney. Urol. & Cutan. Rev., 1919, 23: 260.
10. HARTMEN, G. W. Discussion of Kindall's article.
11. HENLINE, R. B. Spontaneous rupture of kidney. J. Am. M. Ass., 1924, 83: 1411.
12. HERMAN, L. A case of ruptured hydronephrosis. J. Urol., 1927, 18: 458.
13. HUNNER, G. L. Discussion of Kindall's article.
14. KUSTER, E. Zur Entstehung der subcutanen Nierenzereisungen und der Wandernieren. Arch. f. klin. Chir., 1895, 1: 676–686.
15. Idem. Verletzungen der Nieren. Die chirurgischen Krankheiten der Nieren. Deutsche Chirurgie. By v. Bergmann and P. V. Brunn, 123: 721, 526. Stuttgart; Enke, 1896–1902.
16. LE DENTU, A. Affections chirurgicales des reins, des uretèrs et des capsules surrénales. pp. 1–92. Paris: G. Masson, 1889.

17. LEGUEU, F. De l'hydronéphrose traumatique. Bull. Med., Par., 1909, 23: 389.
18. LUCKETT and FRIEDMAN. Pyelography in the diagnosis of traumatic injury of the kidney. Ann. Surg., 1914, 60: 729.
19. MERTZ, H. O. Spontaneous renovisceral fistulæ with report of two cases of renocolic fistulæ. Tr. Am. Ass. Genito-Urin. Surg., 1931, 24: 115.
20. MORRIS, H. Injuries of the Ureter. On the Origin and Progress of Renal Surgery. pp. 127–155. Philadelphia: P. Blakiston's Son & Co., 1898; Edinburgh M. J., 1898, 3: 11.
21. Idem. Injuries of the Kidney. Surgical Diseases of the Kidney and Ureter. Vol. 1, pp. 141–198. London: Cassell and Co., 1908.
22. SCHEDE, M. Injuries of the Kidney. By v. Bergmann and Bull. Vol. 5, pp. 229–241. System of Practical Surgery. Philadelphia: Lea Bros. and Co., 1904.
23. TUFFIER, T. Traumatismes du rein. In Traité de Chirurgie. S. Deplay P. Reclus; G. Masson, 1892; 7: 476–493.
24. VERMOOTEN, V., and MCKEOWN, R. M. Renocolic fistulæ. Am. J. Surg., 1933, 21: 242.
25. WALKER, R. M. Spontaneous rupture of hydronephrosis. Brit. J. Urol., 1933, 5: 139.
26. WALTERS, W. Resection of the renal pelvis for hydronephrosis; its complications and results. Surg., Gynec. & Obst., 1930, 51: 711.
27. Idem. Resections of the renal pelvis for hydronephrosis. Surg., Gynec. & Obst., 1932, 55: 508.

FRACTURES OF THE HUMERUS: END-RESULTS FROM TREATMENT

RALPH K. GHORMLEY, M.D., F.A.C.S., ROCHESTER, MINNESOTA
Section on Orthopedic Surgery, The Mayo Clinic
AND
RUDOLPH J. MROZ,[1] M.D., ROCHESTER, MINNESOTA

THE following review of end-results from treatment of fractures of the humerus covers a 5 year period from January 1, 1926, to December 31, 1930. All cases of fracture of the humerus encountered at the Mayo Clinic during this period are reviewed here. For the purpose of tabulation, we have divided these cases into 8 groups.

Our classification does not conform to the one usually given. In most classifications supracondylar fractures are all grouped with "fractures of the elbow" and in many of such classifications fractures of the neck and head of the humerus are grouped with fractures of the shoulder. We have not attempted to divide supracondylar fractures into the usual groups but have separated fractures of the single condyles, epicondyles, and the capitellum as well as those of the trochlea. This grouping conforms to anatomical types and presents interesting comparative features, particularly in regard to the incidence of late nerve complications associated with injuries about the elbow.

The predominance of old fractures of the shaft will be seen in Table I. This, of course, is a fracture that is seen frequently, but at the same time it must be realized that it is a difficult fracture to treat and one that leads to many unsatisfactory results. This predominance is partly accounted for by the frequent injury of the musculospiral nerve, a complication that in many cases leads to a major complaint, and the frequency with which non-union is also encountered combines with injury of the musculospiral nerve to make up the majority of cases in this group of old fractures of the humerus.

In Table II we have listed the cases of old fracture of the shaft of the humerus according to the main complaint on admission, that is, the chief reason why patients sought further medical advice and treatment. Non-union makes up the largest of these groups, and because of the frequency with which it is encountered in fractures of the humerus it would be expected to be the most frequent complaint. Taking the cases of non-union alone, and adding to them the cases of non-union with nerve injury and non-union with infection, we have a total of 58 cases, or about 65 per cent of the entire group. This group contains a few cases that should be classed as delayed union. We have considered all cases that were seen more than 2 weeks after the time of injury as old fractures. There are, therefore, a few cases that should be classed not as delayed union or non-union but simply as cases of recent fracture with malposition.

Some few patients were given reassurance that their arms would be all right, and this satisfied them. There were 2 pathological fractures in the group, one resulting from a bone cyst and the other almost certainly from parathyroid hyperfunction with osteitis fibrosa cystica. One case was a medicolegal problem only, the patient coming with her lawyer rather than with her physician.

This group of cases represents, of course, a great many failures of treatment elsewhere. From the study it is hard to account for all of these failures; many, perhaps, were due to poor reduction, some, to infection, and so forth. It seems to us, however, that probably the most common cause of failure was too short a period of fixation or inadequate fixation. The humerus is probably the most difficult bone in the body to fix adequately and securely, and it is apparent from the study that this is a common cause of failure in its treatment.

Besides the original surgical treatment in the cases set forth in Table III, in many cases there had been operations for non-union. In all, 44 patients had had surgical operations prior to their admission to the clinic. Several of these patients had had multiple operations performed, as many as 4 in some instances. In all, 78 operations had been performed in these 44 cases, or an average of 1.8 operations per patient.

The problem presented, in these cases, therefore, varied considerably. The non-union group presented the most important problem from the standpoint of the orthopedic surgeon.

In the majority of cases listed in Table IV, treatment consisted of massive bone graft, as described by Henderson. Very little modification in this technique has taken place since that time.

[1]Now residing in Rockford, Illinois.

TABLE I.—FRACTURES OF HUMERUS 1926-1930 INCLUSIVE

	Cases
Shaft old	89
Shaft new	35
Neck and head old	30
Neck and head new	57
Supracondylar old	38
Supracondylar new	39
Condyles, epicondyles, and capitellum old	22
Condyles, epicondyles, and capitellum new	22
Total	341

TABLE II.—FRACTURES OF HUMERUS SHAFT: OLD

On admission:	Cases
Non-union alone	32
Non-union with nerve injury	16
Nerve injury	15
Non-union and infection	10
For reassurance	5
Infection	6
Pathological fracture	2
Limited joint motion	1
Medicolegal case	1
Nerve injury and infection	1
Total	89

TABLE III.—FRACTURES OF HUMERUS SHAFT: OLD

Original treatment (elsewhere)		Cases
Closed		56
Open		33
Lane plate	15	
Parham band	5	
Wired	4	
Nerve suture and repair	3	
Beef bone peg	1	
Beef bone plate	1	
Kangaroo tendon	1	
Bone removed	1	
Metal screw	1	
Open reduction	1	
Total		89

TABLE IV.—FRACTURES OF HUMERUS SHAFT: OLD (89 CASES)—BONE TRANSPLANTS

	Cases treated at clinic	Results		
		Good	Fair	Poor
Massive bone transplants	19	16	1	2
Removal of foreign body or sequestra and bone transplant	10	9	1	
Sequestrectomy and bone graft	4	3	1	
Osteoperiosteal graft with bone screws	3	2		1
Intramedullary and onlay graft	1	1		
Total	37	31	3	3

In several instances, where sequestra were present or where there was any sort of infection, it was necessary to do one or two preliminary operations to prepare the bone for the graft. The removal of foreign fixative substances, such as bone plates or Parham bands, may be done at the same time that the bone graft is applied, provided no infection is present. When infection is present, it should be cleared up and should be quiescent for a period of 6 months to 2 years before a bone graft operation is undertaken.

Care must be exercised to get the ends of the ununited bone to fit together as accurately as possible. One must also drill the eburnated ends, so that a sufficient opening is made into the marrow cavity to allow new circulation to be established through the eburnated bone. The graft is fitted as accurately as possible to the surface of the bone and held with a clamp until beef bone screws can be inserted to hold it in place. A plaster-of-paris body-cast, with the arm in 45 degrees abduction, is applied. Much operative time can be saved by applying the body portion of the cast prior to operation.

At the end of 3 weeks the wound should be dressed and the sutures removed. The period of fixation with the plaster after this varies considerably. In most instances union will be firm enough at the end of 3 months to allow removal of the cast and the use of a sling. However, one must be guided by examination of the part, both by roentgenogram and by physical examination. Too long a fixation period is far better than one that is too short. In a few cases it may be safe to change from a plaster-of-paris cast to an aeroplane splint at the end of 8 weeks. However, as a rule it is much safer to continue with the plaster cast until the end of 3 months at least. Rehabilitation should be carried out only after one is certain that union has taken place. Massage and active exercises should be the modes of re-establishing movement of the affected part.

In cases where infection was the predominating cause of complaint, treatment was carried out according to the stage of the infection, and, when sequestra were present, they were removed surgically. In general a modified Orr treatment was used for osteomyelitis (Table V), that is, thorough surgical preparation of the wound, using vaseline gauze packs as dressings. These were usually changed once a week to prevent the odor from becoming too offensive.

The cases summarized in Table VI present nerve complications as the most important physical finding and make up a large group; they will be dealt with more fully in another paper. This table is inserted here to complete this statistical study.

As we have stated before, all fractures under 2 weeks' duration have been considered new fractures. In the group in Table VII there were 35 of these fractures over the 5 year period, and the

TABLE V.—FRACTURES OF HUMERUS SHAFT: OLD (89 CASES)—MISCELLANEOUS TYPES

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Sequestrectomy	7	3		2	2
Splint	4	1		2	1
Physiotherapy	4	1	1		2
Open reduction with bone screws	3	1		1	1
Removal of foreign body or sequestra	3	1	1	1	
Pathological, no treatment	2			1	1
Beef bone plate	1	1			
Cast	1	1			
Total	25	9	2	7	7

No orthopedic treatment given: 27 cases. Refused, advice only, compensation, satisfactory, etc. (Neurological cases included).

TABLE VI.—FRACTURES OF HUMERUS SHAFT: OLD (89 CASES) COMPLICATING NERVE LESIONS*

	Cases treated at clinic	Results			
		Complete recovery	Partial recovery	No recovery	Unknown
Non-surgical treatment	19	6	2	8	3
Surgical treatment					
Explored, no suture	2			2	
Explored, neurolysis	4	2			2
Explored, sutured	5	3		1	1
Brachial plexus avulsion	5			4	1
Median nerve	1			1	
Ulnar nerve, sutured	1				1
Total	37	11	2	16	8

*Musculospiral: primary, 22 cases; secondary, 8 cases.

way these were treated and the results obtained are indicated in the table.[1]

In the consideration of the treatment of acute fracture of the shaft of the humerus, several facts are of importance in coming to a conclusion as to the type of treatment best suited to the case. Simple transverse fractures are best held by some

[1]We have used the terms good, fair, poor, and unknown. As good results, were classed all those cases in which firm bony union without deformity and with practically no limitation of motion was obtained. Under fair results were classed the cases in which firm bony union followed but with some deformity or limitation of motion. Under poor results were classed the cases in which union was not obtained or in which there was some impairment of function or deformity sufficient to make the patient seriously handicapped by the result. Unknown results apply to those cases which we were unable to trace. It should be noted also that in many cases where no treatment was recommended here, particularly in the case of old fractures without any prospect of improvement, no follow-up was attempted.

TABLE VII.—FRACTURES OF HUMERUS SHAFT: NEW (35 CASES)

	Cases treated at clinic	Results		
		Good	Fair	Unknown
Open (11 cases)				
No internal fixation	4	1	2	1
Beef bone plate	3	3		
Beef bone screw	2	2		
Beef bone screw and Parham band	1	1		
Lane plate	1	1		
Closed (24 cases)				
Cast	8	6		2
Aeroplane splint	7	6		1
Velpeau bandage	4	3		1
Not treated	3*	1		
Bed traction	1	1		
Both humeri	1	1		
Total	35	26	2	5

*Two dead.

form of internal fixation, either a bone plate or a beef bone screw. In many cases it is extremely difficult to get enough engagement of the fragments without internal fixation to hold the fracture either in a cast or in an aeroplane splint. Oblique or spiral fractures are more easily held in most instances, but excellent position may be obtained by the use of some form of internal fixation, either a beef bone screw or a Parham band.

As will be seen in the table, in most cases treatment consisted of either a cast or an aeroplane splint with traction. Often when a cast was used, some type of traction was also used, making a fixed traction type of support. When traction is used, it should always be checked carefully with the roentgenogram, to prevent the fragments from being pulled apart. Comminuted fractures of the humerus must always be considered most favorable for such treatment because of the difficulty in getting sufficient fixation by any form of internal fixation.

In the 2 cases in which the patients died, there were severe multiple injuries, and fractures of the humeri were merely incidental to the cause of death. Fractures treated with Velpeau bandages were green stick fractures without enough separation to require any additional fixation. "Bed traction" is shown as having been used in only 1 case. As a matter of fact, it was used in a considerable number of cases preliminary to casts or

TABLE VIII.—FRACTURES OF HUMERUS NECK AND HEAD: OLD (39 CASES)*

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Neck and head (21 cases)					
Physiotherapy	11	6	2		3
Aeroplane splint	2				2
Open, beef bone screw	4	3	1		
Excision head	2		2		
Removal wire	1				1
Manipulated	1	1			
Greater tuberosity (6 cases)					
Physiotherapy	2				2
Manipulation	2	1		1	
Aeroplane splint	1				1
No treatment	1				1
Epiphyseal separation					
Open, beef bone screw	1	1			
Osteomyelitis					
Sequestrectomy	3				3
Total	31	12	5	1	13

*8 cases had no treatment.

TABLE IX.—FRACTURES OF HUMERUS NECK AND HEAD: NEW (57 CASES) (SURGICAL NECK, 38 CASES)

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Surgical neck, simple (28 cases)					
Aeroplane splint	14	8	2	1	3
Open, beef bone screw	8	4	1		3
Open, no fixation	2	1	1		
Cast	3	2	1		
Bandage	1			1	
Surgical neck, comminuted (4 cases)					
Aeroplane splint	3		1		2
Open, no fixation	1	1			
Surgical neck, comminuted with dislocation of head (4 cases)					
Aeroplane splint	2	1			1
Open, no fixation	2	1		1	
Surgical neck impacted (2 cases)					
Aeroplane splint	2	2			
Total	38	20	6	3	9

to aeroplane splints; in the more severe injuries it is a necessity. In fractures of the humerus with some over-riding or deformity, bed traction will be found very useful in reducing the deformity and improving the position. In cases of severe swelling in which rest is needed, it is a practical method of obtaining correction of the position and absolute rest in bed at the same time.

One case of fracture of both humeri is listed. These are difficult cases in which to secure proper fixation. The use of the aeroplane splint is difficult and oftentimes impossible. A double cast is the most satisfactory fixation, provided one gets accurate replacement. We feel that in these cases, where conditions permit, internal fixation of at least one bone will give the best results. Bed traction cannot be continued in these cases for over a few days at a time.

In many ways the cases listed in Table VIII are the most difficult types in which to obtain satisfactory results. Old stiff shoulders, especially those with dislocation or deformity, offer about as unfertile a field for obtaining successful results as anyone can imagine. However, in many instances marked improvement can be obtained with persistent and skillfully applied physiotherapy, particularly with active and passive movements. Fractures treated by open reduction with beef bone screws were comparatively recent ones in which reduction could be accomplished. The 2 cases in which excision of the humeral head was done were old fractures of the neck with dislocation of the head. These are without doubt the most unsatisfactory cases of all for successful treatment. Excision of the head of the humerus does not give a good result. It does, as a rule, however, relieve pain, and it may relieve pressure on the nerves in the axilla, thus preventing or minimizing the secondary nerve changes that often take place.

A group of 6 cases of fracture of the greater tuberosity are included in this table. Unless marked displacement takes place in these fractures, no special attempt at reduction is necessary. Some advocate abduction of the arm by the use of an aeroplane splint to prevent displacement of the fragments by the pull of the supraspinatus and infraspinatus tendons. Unfortunately, in this particular group we were able to follow only 2 cases in both of which there had been attempts to improve the movement in the shoulder by manipulation. This is a procedure of value in some cases, but we must emphasize the fact that

TABLE X.—FRACTURES OF HUMERUS NECK AND HEAD: NEW (57 CASES)

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Anatomical neck (13 cases)					
Aeroplane splint	4	3	1		
Open, no fixation	3			2	1
Open, beef bone screw	2	1	1		
Bandage	4	2	1		1
Greater tuberosity (4 cases)					
Aeroplane splint	1	1			
Open, beef bone screw	1	1			
Cast (dislocation)	1	1			
Sling	1				1
Lesser tuberosity					
Sling	1	1			
Pathological (giant-cell tumor)					
Curettement and bone graft	1	1			
Total	19	11	3	2	3

TABLE XI.—FRACTURES OF HUMERUS (SUPRACONDYLAR): OLD (38 CASES)

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Deformity (12 cases)					
Physiotherapy	6	1	1	1	3
No treatment	2		1		1
Open reduction	1	1			
Advised operation (not done)	1				1
Arthroplasty	1			1	
Transplant ulnar nerve	1	1			
Limited motion (14 cases)					
Arthroplasty	3			2	1
Physiotherapy	3	2			1
No treatment	6			2	4
Capsulotomy	1		1		
Manipulation	1			1	
Limited motion and infection					
Drainage	2	1			1
Myositis ossificans	1	no treatment			
Osteochondritis dissecans					
Removal of loose bodies	1	1			
Total	30	7	3	7	12

it must be used with a great deal of care in the treatment of old fractures, because of the danger of pathological fracture when atrophy through disuse is marked.

In the group in Table IX we again return to the more acute fractures, and we have tabulated the fractures of the surgical neck. As will be seen in this table, the most frequently used type of treatment was the aeroplane splint. In these cases a splint without traction should be used. It should be carefully fixed with adequate support to hold it up into the axilla. At the clinic, we make each splint to fit the individual patient. When much malposition or displacement is present, manipulation under anæsthesia is the routine before application of the splint. Where satisfactory reposition of the fragment cannot be obtained, we feel that open operation is indicated, and the most useful form of internal fixation has been the beef bone screw. In some cases no internal fixation is necessary. Good alignment can thus be obtained, and the results have well justified the means. No poor results were obtained in any of the fractures treated by open reduction. In estimating these results we have only listed as good results those with union without deformity and with practically a normal range of motion. Those with fair results included the cases in which union was obtained but in which normal motion was not recovered, although in most of these there was sufficient motion to allow use of the shoulder.

It will be noted in Table X that in these cases open reduction did not produce as good results as in fracture of the surgical neck. Usually fracture of the anatomical neck presents a much more difficult problem because of the small size of the proximal fragment. When severe displacement occurs, however, it is often impossible to obtain satisfactory reduction by manipulation and open methods must be resorted to. These types are usually more serious and are doomed to a very unsatisfactory result if left alone.

Strangely enough the 4 fractures of the greater tuberosity were each treated in a different manner. All the results were satisfactory where final reports were available, which goes to show that any method of treatment that is carried out carefully may produce good results in this type of fracture.

One fracture of the lesser tuberosity and one pathological fracture in a case of giant cell tumor of the head of the humerus are included in the list and need no comment.

TABLE XII.—FRACTURES OF HUMERUS (SUPRACONDYLAR): OLD (38 CASES)

	Cases treated at clinic	Results		
		Fair	Poor	Unknown
Volkmann's ischæmic paralysis (8 cases)				
Splint and physiotherapy	4	2	1	1
Tendon plastic	2	2		
Osteotomy	1		1	
No treatment	1			1
Total	8	4	2	2

TABLE XIII.—FRACTURES OF HUMERUS (SUPRACONDYLAR): NEW (38 CASES)*

	Cases treated at clinic	Results		
		Good	Fair	Unknown
With displacement (29 cases)				
Manipulation, acute flexion	17	14	2	1
Open, beef bone screw	5	2	3	
Open, catgut fixation	7	2	3	2
Without displacement (4 cases)				
Cast	2	2		
Sling	1	1		
Acute flexion	1	1		
Total	33	22	8	3

*5 cases not treated here.

The group of cases in Table XI represents a type of fracture in many ways as difficult to treat as old fractures of the head and neck of the humerus. In fact, this type may be regarded as worse because it is with these fractures that Volkmann's ischæmic paralysis occurs and in many of the cases there are complicating injuries of the ulnar nerve in addition. No special form of treatment seems to be applicable, and each case is a problem in itself.

We have divided the cases according to those in which the chief complaint was of deformity and those in which it was of limited motion. Arthroplasty in these cases does not offer a great deal, if we are to judge by the results obtained in this group. It should not be entirely condemned, however, as we have seen occasional good results from its use. Attempts to correct the deformity, except in fairly recent cases, usually meet with unsatisfactory results. Again, skillfully handled physiotherapy is the most useful method of treatment. We do not feel that manipulation in these cases offers much. We have occasionally seen cases where numerous manipulations have been carried on over a period of several weeks' convalescence. Usually the results are not good.

The group of cases of Volkmann's paralysis presented in Table XII is fairly representative of results in such cases. In 2 cases in which treatment consisted of Jones' ischæmic paralysis splints and physiotherapy there was some improvement. In 2 cases in which tendon plastic operations were done there were fair results. The degree of success in these cases is inversely proportional to the severity of the deformity and paralysis.

The end-results in this group of new supracondylar fractures (Table XIII) emphasize the fact that adequate early treatment may prevent many poor results. We have 3 essential things to consider in this group: (1) the reduction of the fracture, which is of the utmost importance and should be accomplished in as short a time as possible; (2) the hæmorrhage that may take place, causing a swelling which must always be considered a potential source of trouble, particularly because of the possibility of development of Volkmann's ischæmic paralysis; and (3) the type of fixation, which must not be constricting enough to cause any further impairment of circulation and must not cause compression of the musculospiral nerve.

The need for adequate early reduction and proper fixation is recognized by all. When there is marked swelling, however, as a rule something must be done to relieve it. Elevation of the arm may be used, but it is a slow method and, for this reason, somewhat dangerous. We have aspirated hæmatomata of large size as a means of reducing the swelling. The other alternative is open reduction, which of course evacuates the blood clot and relieves tension, so that much of the danger of ischæmia is averted. In difficult cases with marked swelling, we feel that it is the choice method of treatment, provided facilities are at hand for carrying out careful bone surgery.

The choice position of fixation in these cases is acute flexion, although such a position is not without danger, as has already been indicated. If swelling is great, flexion to an acute angle may further embarrass the circulation. A position must be employed in which the radial pulse can be felt. Furthermore, any type of constricting dressing must either be watched carefully or else not used. If adhesive strips are used to hold the angle of fixation, they must be placed so as to avoid pressure on the musculospiral nerve. In

TABLE XIV.—FRACTURES OF CONDYLE AND CAPITELLUM: NEW (22 CASES)

	Cases treated at clinic	Results		
		Good	Fair	Unknown
Capitellum (6 cases)				
Open, removal fragment	2	1	1	
Open, beef bone screw	1	1		
Open, fragments sutured	1	1		
Sling	2	2		
Radial condyle (8 cases)				
Acute flexion	2	2		
Open suture	2	1	1	
Sling	2	2		
Physiotherapy	2	1		1
Ulnar condyle (3 cases)				
Excision	2	2		
Sling	1	1		
Ulnar epicondyle (4 cases)				
Acute flexion	2	2		
Open, beef bone screws	1			1
Sling	1	1		
Radial epicondyle (1 case)				
Acute flexion	1	1		
Total	22	18	2	2

TABLE XV.—FRACTURES OF CONDYLE AND CAPITELLUM: OLD (22 CASES)

	Cases treated at clinic	Results			
		Good	Fair	Poor	Unknown
Radial condyle (11 cases)					
No treatment	4	1			3
Physiotherapy	4		1	2	1
Ulnar nerve transplant	1			1	
Advised nerve transplant	1		1		
Removal of wire	1		1		
Ulnar condyle (8 cases)					
No treatment	3				3
Physiotherapy	2				2
Ulnar nerve transplant	2		1		1
Volkmann paralysis (tendon plastic)	1	1			
Radial epicondyle (1 case)					
Ulnar nerve transplant	1	1			
Ulnar epicondyle (1 case)					
No treatment	1				1
Capitellum (1 case)					
Advised operation (refused)	1				1
Total	22	3	4	3	12

many cases a moulded, posterior, plaster-of-paris splint is the safest sort of dressing.

Early motion is desirable. But, unless early motion can be supervised by the surgeon himself, or by an expert physiotherapist, disappointing results may ensue. In children, under proper conditions, motion may be begun at the end of 1 week, provided perfect reduction has been accomplished. However, it is safer to wait from 10 days to 2 weeks before starting such movement in most cases.

One must not be distressed at slow recovery of movement. Children are often very slow to push their activities to the point of pain. Patience and time will, in most instances, produce excellent results. Impatience, resulting in manipulations under anæsthesia, may produce a persistently painful elbow without any improvement in motion.

This group of fractures (Table XIV) has been classed separately because, for the most part, they make up an entirely distinct group. By distinct is meant that they should be distinguished from the usual supracondylar fracture. We found in reviewing our cases that in many the diagnosis was not accurate when filed, and only by reviewing the roentgenograms were we able to make the correct diagnosis. Fractures of one or the other condyle are almost certain to lead to trouble if not accurately reduced. Two complications must be looked for: (1) an almost certain bony deformity, either cubitus valgus or varus, depending on whether the internal or the external condyle is displaced; (2) tardy ulnar palsy. Of 8 cases of late paralysis of the ulnar nerve, in 4 there were fractures of the radial condyle, in 3 of the ulnar condyle, and in 1 the diagnosis was intercondylar fracture. Accurate replacement of these fragments, then, is of the utmost importance, and in case of inability to get them back into position by closed reduction one should not hesitate to perform open reduction. When no displacement is present, and this is often the case, the problem is simply one of proper fixation. When severe comminution of either condyle or capitellum takes place, the best treatment is removal of the bone fragments.

The group of old cases in Table XV presents an unsatisfactory group from the standpoint of treatment. The reasons are obvious. Severe de-

formities caused by upward displacement of one or the other condyle are very unsuccessfully treated by surgery.

Transplants of the ulnar nerve in these cases will be reviewed in another paper. The fact that among the 22 cases either no treatment or physiotherapy was advised in 14 shows how little could be offered from the standpoint of reconstructive surgery.

SUMMARY

We have reviewed 341 cases of fracture of the humerus seen over a 5 year period at the Mayo Clinic. These comprise all types, new and old, and are grouped according to anatomical type. Each group is discussed briefly. The old fractures of the shaft offer the most interesting group from the standpoint of bone surgery. Out of 37 such cases, good results were obtained in 84 per cent and poor results in 8 per cent.

REFERENCES

1. Henderson, M. S. Non-union of the humerus, etc. South. M. J., 1921, 14:148-153.
2. Idem. Non-union in fractures: the massive bone graft. J. Am. M. Ass., 1923, 81: 463-468.

ACUTE MECHANICAL INTESTINAL OBSTRUCTION: MORTALITY WITH AND WITHOUT ENTEROSTOMIES

Based on a Review of 241 Cases from the Records of the Cook County Hospital

AMOS FEY, M.D., Galesburg, Illinois, and WILLIAM R. CUBBINS, M.D., F.A.C.S., Chicago

DURING the past 15 years the literature has been filled with accounts of the value of enterostomies advising their performance when in the least doubt of an obstruction, and claiming marvelous results. These claims have not been made with any qualifying statement that the quoted results can be obtained in certain skillful hands, but have been broadcast in such a manner as to lead one to believe that any individual can make an enterostomy in any particular portion of the small bowel with little or no danger to the patient, and with a great certainty as to the ultimate favorable outcome; in other words, that enterostomy is a definite and distinct life saving procedure. Its advocates have apparently forgotten the struggles of Nicholas Senn, Jacob Frank, John B. Murphy, and others, to overcome the great morbidity associated with enterostomy, a procedure which had been in use for several centuries, by perfecting a means of end-to-end or lateral anastomosis.

Many writers recommend the making of enterostomies, but do not mention any attempt whatever to relieve the obstruction. The accompanying case histories from Cook County Hospital, which have been studied with great care, show the mortality of an acute intestinal obstruction in relation to enterostomies of any kind, as well as the mortality of resections. They also show the great value of an early exploratory operation when there is any doubt concerning an acute intestinal obstruction, whether it be complete or incomplete.

The mass of experimental work that has been done upon intestinal obstruction has so many different angles that it would be impossible to attempt to discuss adequately every phase of that problem in this article. We can, however, say with certainty that most of it has been fruitless and serves only to confuse us in our efforts to lessen mortality unless an early operation is performed and, if possible, the obstruction is also removed.

We have reviewed 241 cases from the records of the Cook County Hospital. From this mass of material we have attempted to extract a few facts that will be helpful in handling this serious surgical emergency without attempting to discuss every controversial point which would lead us away from clinical cases to an involved discussion of the theories and experimental work.

The case records reviewed cover all cases filed under the head of "Acute Mechanical Intestinal Obstruction" during the years from 1922 to 1931. This does not include strangulated external hernias or chronic obstructions, which are filed separately and which present a somewhat different problem. For the purposes of statistical study, only those cases operated upon are included. Cases of obstruction secondary to carcinoma or intra-abdominal abscess are not included because of complications peculiar to this type of case. A few of these cases were not completely obstructed, but all were of the acute type which constitutes a surgical emergency.

ETIOLOGY

For the sake of brevity we shall discuss under etiology only the type of case reviewed. A more complete discussion of the whole subject would properly include adynamic ileus, ileus due to peritonitis, mesenteric thrombosis, and cases mentioned in the preceding paragraph.

The relation of age and sex to the occurrence of acute mechanical intestinal obstruction is shown in Table I. The condition is quite evenly divided between the sexes. After the age of intussusception it decreases in childhood and is evenly distributed throughout adult life. Except that intussusception occurs in infancy, usually below the age of 2, age is of little value in diagnosis.

Adhesions, forming bands or kinks, and foramina through which the bowel may herniate, are the most common causes of mechanical intestinal obstruction (Table I). They account for 74 per cent of the cases in this series. It is important to note that 34, or 19 per cent, of these cases due to adhesions had had no previous surgery. Cases due to postoperative adhesions were most common following surgical procedures for intra-abdominal infection. There were included in the pelvic operations, however, 15 hysterectomies which were not associated with known pelvic infection. The miscellaneous operations include gunshot wounds and various operations too infrequent to classify separately.

In the 34 cases due to adhesions not associated with previous surgery, the cause was not determined in 23. In the 11 remaining cases in which the cause was determined, the frequency and variety of inflammatory insults that are the common cause of adhesions are clearly demonstrated.

Intussusception is the next most common cause of mechanical obstruction; (21 in this series—8.7 per cent). The majority occur in infancy below the age of 2. In the 4 occurring in later years, 2 were due to benign tumors, and in 2 no cause was found (Table I).

Internal hernias occurred in 5 per cent of the cases in this series. These are cases not produced by adhesions and the cause of these foramina cannot be definitely stated. The most probable explanation is that they were of congenital origin (Table I).

Volvulus occurred in 3.7 per cent of the cases. Many of the cases of volvulus are really due to adhesions and where the etiologic factor seemed solely the result of adhesions, they were classified under that heading. True volvulus not associated with adhesions or previous operative procedures is rare and in this series constituted only 1.7 per cent of the cases (Table I).

Meckel's diverticulum causes obstruction due to either the formation of adhesions around an inflamed diverticulum or inversion and intussusception. As a cause of intestinal obstruction it occurs about as frequently as a true volvulus in this series of cases. Other rare causes are shown in Table I.

That acute mechanical obstruction can be produced by a variety of causes must be kept in mind when making a diagnosis. The fact that no known etiological factor is apparent from the history and examination of the patient should not be confusing when the other symptoms and physical findings are present.

TABLE I.—SEX AND AGE INCIDENCE AND ETIOLOGY

		Cases
I. Sex		
Male		110
Female		129
Infants (sex not noted)		2
		241
II. Age		
Infancy (under 2 yrs.)		14
2 to 10 years		10
11 to 20 years		25
21 to 30 years		48
31 to 40 years		63
41 to 50 years		30
51 to 60 years		17
61 to 70 years		15
71 to 80 years		1
81 years		1
Age not noted		18
		241
III. Etiology		
A. Adhesions	(74%)	170
Cause of adhesions:		
1. Previous surgery		137
a. Previous pelvic operations	66	
b. Previously operated upon for appendicitis	49	
c. Miscellaneous operations	22	
2. No previous surgery		34
a. Cause not determined	23	
b. Apparent cause determined	11	
1. Old inflammatory changes in region of appendix	4	
2. Old tubal disease	2	
3. Adhesions to large mesenteric gland	2	
4. Adhesions to ovarian cyst	1	
5. Radium treatment for cancer of cervix 6 months before	1	
6. Adhesions to ectopic pregnancy	1	
3. Not noted whether previous surgery and cause not determined		8
B. Intussusception		21
1. In infancy	17	
2. Due to benign tumors	2	
a. Multiple polyposis	1	
b. Fibroma	1	
3. At the age of 15	1	
4. Compound chronic in adult	1	
C. Internal hernia		12
1. Through hole in omentum	4	
2. Through hole in mesentery	3	
3. Diphragmatic hernia	1	
4. Femoral ring	1	
5. Obturator foramen	1	
6. Internal inguinal ring	1	
7. Cause not known	1	
D. Volvulus		9
1. Related to previous surgical procedures	5	
2. No previous surgery	4	
E. Meckel's diverticulum		4
1. With adhesions	3	
2. Inversion with intussusception	1	
F. Other congenital anomalies		2
1. Fetal mucous colitis	1	
2. Congenital closure of ileum and large bowel	1	
G. Foreign body		2
1. Type not ascertained, but probably gall stone	1	
2. Gall stone	1	
H. Trauma		1
1. Interposition of hepatic flexor between liver and diaphragm	1	
I. Obstruction to pressure from mesenteric gland		1
J. Previously reduced strangulated hernia (with gangrene of bowel at operation)		1
K. Etiology not found		9

SYMPTOMATOLOGY

The cardinal symptoms of intestinal obstruction were pain, nausea, vomiting, and constipation.

Pain was usually the first symptom complained of. It was invariably present. Its character is of diagnostic importance. The early pain was probably due to increased peristalsis as the bowel struggled to force its contents past the obstruction. It was intermittent, occurring at intervals which varied somewhat with the type, completeness, and duration of the obstruction. Auscultation will show peristalsis in many cases to be most active at the height of the pain. This type of peristaltic pain is important diagnostically as it is quite different from that due to peritoneal irritation. The location of the pain was most often in the region of the umbilicus, but did occur in other regions of the abdomen; however, it was not well localized and could not be used as an indication of the location of the obstruction. As distention

and prostration increased and peristalsis decreased, the pain became more generalized and in many cases was less severe.

Nausea and vomiting occurred at, or a short time after, the onset of the obstruction, the interval depending on the completeness and location of the obstruction. Vomiting increased in frequency as the obstruction became more severe. The character of the vomitus changed and became foul—slowly, if obstruction was incomplete; rapidly, if it was complete.

Obstipation was as constant as pain and vomiting, but often more confusing in its interpretation and determination. A patient may be constipated before the actual onset of obstruction or the obstruction be so fulminating that the lack of a bowel movement since onset is not abnormal. The determination of obstipation by the use of the enema is a subject about which there is some current controversy. In this series of cases enemas gave valuable information. The results of enemas as an aid in diagnosis may, however, be misleading unless interpreted properly.

Wangensteen has shown in dogs that a bowel may evacuate itself below a complete obstruction after an enema, and has observed the same phenomenon in clinical material. One of us operated for an obstruction 2 hours after gas and fæces were obtained by an enema, and found a gangrenous bowel. We have also observed that a bowel may evacuate itself early due to the initial insult of a developing obstruction and thereafter very little if any gas will form distal to the obstruction. It must be remembered that it is probably impossible to tell the exact time when a partial obstruction becomes complete, and that there may be results from an enema in case of a partial obstruction that may rapidly progress to completeness. Enemas were given in 97 cases classified as nearly as possible by the operative findings as complete obstruction. In 86 cases, or 88 per cent, the enema was returned clear or slightly colored; usually "poor results" was the notation used in the chart. In 11 cases, or 12 per cent, good or fair results were obtained, but in only 2 of these cases was a second enema given which gave a return of fæces and gas. In 7 cases classified under "poor or no results," the first enema gave a return of fæcal material and gas, and the second no results. Results of enemas given were noted in 17 cases classified as partial obstruction. Good results were noted in 10 cases, or 58.8 per cent, and poor results in 7 cases, or 41.2 per cent. When the diagnosis is in doubt, a second enema should be given. The records of the enemas did not in every case indicate the results completely and accurately. Much better information will be obtained if the surgeon is present when the enema is given, rather than relying on the observation of the nurse. It is evident from these statistics that the results of enemas must be properly interpreted if they are to be of value in making a diagnosis of mechanical obstruction. Peristalsis should be present, indicating that the bowel is attempting to empty itself and that diffuse peritonitis is absent. If fæces and gas are obtained, and the symptoms of distention, pain, and vomiting are not relieved, one may be certain that the obstruction continues and surgery is indicated. Results after an enema are not a contraindication to surgery unless the patient is relieved, and in many cases symptoms will recur requiring surgery. If fæces and gas are obtained from the first enema, further enemas will usually be returned without gas or fæces if the obstruction is complete or approaching completeness.

PHYSICAL FINDINGS

Intestinal obstruction was not associated with a constant rise in temperature in this series of cases. In those cases without gangrene, 44 per cent were from 97 degrees to 98.6 degrees; 27 per cent were elevated less than 1 degree; 25 per cent elevated from 1 to 2 degrees; and 3 per cent elevated over 2 degrees. Less than 1 per cent were under 97 degrees. Rather surprising was the fact that those cases with gangrene showed practically the same temperature changes. While temperatures over 100 degrees are not the usual finding, a small number of cases had a temperature of from 101 to 103 degrees. These temperatures were only slightly more frequent in those cases with gangrene. A rise in temperature of over 101 degrees occurred in a few cases without gangrene or marked damage to the bowel wall. These may probably be explained on the basis of dehydration.

There was no correlation between the temperature and leucocyte count. The mouth temperature, if taken when the patient is dehydrated and mucous membranes are dry, may give readings lower than the true temperature taken in the rectum. There was a rather constant increase in pulse rate which seemed to have a definite relation to the toxicity of the patient. The respiratory rate increased with the development of distention.

Distention varied with the duration and completeness of the obstruction. Some complete obstructions with gangrene had little distention when high in the intestinal tract or of short duration. Some partial obstructions demanding surgery had no distention.

Tenderness to palpation was present more often than one would assume from the writings on intestinal obstruction in surgical textbooks. Of 214 cases, it was noted as present in 167 and absent in 47. There was no typical distribution of tenderness. In many cases it was present throughout the abdomen. In those cases where a mass was palpable, tenderness was most often localized or most marked in the region of the mass.

Rigidity was noted in 41 cases, 20 of which were complicated by the presence of gangrene. The terms "tenderness" and "rigidity," as noted by different examiners, may be somewhat confusing, but at any rate they seemed to have been more common than generally expected. We should like to be able to state the degree of damage to the bowel in those cases in which rigidity was noted and actual gangrene was not present, but this is difficult to do from records made by a number of observers.

The most important abdominal finding is increased peristaltic activity. Table II shows the occurrence of peristalsis. In determining the presence of peristalsis, auscultation is the most valuable method. Visible peristalsis was noted in only a few cases. Audible evidence of peristalsis was intermittent and was occasionally missed at first, during a cursory examination, only to be noted at a second examination. In a few high obstructions it was heard only in the epigastrium. In a few cases it was heard in one side of the abdomen and not in the other.

In this series there were 32 cases in which absence of or decreased peristaltic sounds were noted on physical examination and at operation no gangrene or peritonitis was found. Eighteen of these patients died, a mortality of 56 per cent. Comparing this with a mortality of 28.5 per cent for the entire number of obstructions without gangrene, we are impressed with the importance of diminished or absent peristaltic sounds as an indication of bowel injury, even in the absence of actual gangrene.

In Table II, the data on absence of peristaltic sounds in gangrene of the bowel are shown. In a few of these cases peristaltic sounds apparently continued a short time after the occurrence of strangulation gangrene. However, in most cases the advent of gangrene stopped the audible peristalsis after a short interval. In other cases with marked distention, peristaltic sounds had ceased some time before the occurrence of gangrene.

TABLE II.—PRESENCE OR ABSENCE OF PERISTALSIS OBSERVED IN 177 CASES

		Cases	Per cent
Without gangrene		152	100
1. Increased	89		
2. Present or normal	31	120	79
3. Decreased	10		
4. Absent	22	32	21
With gangrene		25	100
1. Absent	18		
2. Diminished	5	23	92
3. Normal	2	2	8

LABORATORY EXAMINATIONS

Our observations regarding blood counts are not entirely in accord with statements in current surgical works which state that acute obstruction is not accompanied by a leucocytosis unless gangrene or peritonitis is present. Such factors as dehydration and in some instances the transmission of infective organisms through the bowel wall before actual gangrene occurs, make the leucocyte count difficult to evaluate. In those cases without gangrene, 61 per cent had a leucocyte count above 10,000, with 27 per cent above 14,000, and a few ranging above 20,000. In cases in which gangrene had occurred, 90.5 per cent were above 10,000 and 66 per cent above 14,000. We think it is important to emphasize the fact that leucocytosis is not to be relied upon in determining the onset of gangrene. Of the cases with gangrene 33⅓ per cent had a leucocytosis lower than 27 per cent of the cases without gangrene. It appears that the leucocyte count is not as reliable in determining advent of gangrene as the patient's other physical findings.

Urine examinations in this series did not show any typical findings.

Chemical examinations of the blood have not been done in sufficient number to draw conclusions. From a study of the literature on the subject, we feel that blood chemistry determinations have nothing like the value of the patient's symptoms and physical findings in determining the diagnosis and prognosis. Delay in order to make such determination would be inexcusable.

MORTALITY

The mortality of acute mechanical intestinal obstruction has not changed in the past 30 years. The mortality of this entire series is 42.7 per cent. The mortality rate in series of cases by operators in other large hospitals ranges from 23.5 per cent to 60.9 per cent. No attempt is made to compare these rates, for the series would vary as to types of cases included. There have been series of cases reported by single operators with mortality rates as low as 16 per cent. Research regarding the cause of death has added little of value in reducing fatalities.

We are startled to observe that the statistics in Table III do not indicate a higher mortality due to delay, knowing as we do the positive danger of delay in the given case. Statistics notwithstanding, delay in operation is not excusable. Every case of partial or complete obstruction carries with it the possibility of a damage to the blood supply of the bowel that cannot be determined before operation. In some of the cases obstruction was partial for a variable length of time before becoming complete or producing gangrene; it is difficult or impossible to select the case with which one may safely temporize. Table III also indicates the frequency with which the deaths, in the cases of obstruction that were operated on early, are due to strangulation of a loop. It is obviously difficult to draw conclusions as to the increase of mortality due to delay in surgery when this type of case is included in the cases of short duration. If we omit the cases of gangrene and obstruction in infancy we have a mortality of 13.7 per cent for cases of acute obstruction without gangrene operated on in the first 48 hours. There were 46 cases in which delay in surgery occurred because of a diagnosis of partial obstruction. Some of these were cases of several days' duration at entrance, with a history of mild symptoms; presumably they were partial and delay was perhaps justified by that assumption. In other cases, partial obstruction was diagnosed and interference was delayed because results were obtained by an enema, or because there was little distention or the patient had a bowel movement after admission. Seventeen of these 46 patients died—a mortality of 36.9 per cent. In only 4 was there a gangrenous bowel found at operation. The mortality is higher than for all those cases without gangrene (28.5 per cent). In these cases, complete obstruction was not diagnosed even on entrance to the hospital and in many cases was not present at operation; apparently the longer duration, producing severe damage to the bowel, was the factor responsible for the high mortality.

Mortality increases in proportion to duration of symptoms in cases of intussusception in infancy. There were 16 cases with 8 deaths. In 10 the duration was less than 48 hours and there were 3 deaths among these. Of 6 cases with a longer duration than 48 hours, only 1 recovered. Obviously, intussusception diagnosed and operated upon early should carry a low mortality.

Table IV gives interesting data regarding the use of drainage of the bowel and enterostomy. In these cases draining the bowel at operation and closing the opening apparently did not accomplish the results hoped for. Table IV shows an increased mortality for the procedure, which does not seem entirely accounted for by the fact that the cases in which it was used were more serious than those in which the bowel was not opened. A comparison will show that the mortality equals that for resection of a gangrenous loop.

TABLE III.—MORTALITY ACCORDING TO DURATION

	Cases	Deaths	Mortality per cent
24 hours or less	20	7	35
25 to 48 hours	35	10	28
49 to 72 hours	33	15	45
73 to 96 hours	43	16	37
97 to 120 hours	31	13	45
121 to 144 hours	14	9	64
145 hours and over (including partial obstructions)	58	28	48
Not noted	7	5	70

Summary of deaths in cases with a duration of 48 hours or less.

Gangrene by strangulation of loop	9
Intussusception in infancy	3
Congenital occlusion of ileum	1
Notes incomplete	2
Adhesions without gangrene	1
Bowel accidentally torn	1

ENTEROSTOMY

In the few cases of obstruction in which enterostomy was done and the obstruction was relieved as well, the mortality again was as high as that for resection and anastomosis for gangrene. It was noted in some of these cases that enterostomy had not drained the partially paralyzed bowel effectively, and that distention had continued. In this series of cases enterostomy has not reduced mortality, contrary to the claims of some writers. Enterostomy without relief of the obstruction was done in 8 cases of this series with 8 deaths. From these statistics it would seem that enterostomy does not preclude rupture of a gangrenous loop nor does it restore its viability, and apparently it does not prevent the development of gangrene if the obstruction is not surgically relieved.

The results of the treatment of gangrenous bowel also are shown in Table IV. The cases in which gun barrel fistula was done may have been more serious than those in which resection and anastomosis was the procedure used. Admittedly it is difficult to draw conclusions from a series of cases done by different operators, but the mortality of exteriorization or gun barrel fistula is so high in this series that resection and anastomosis seems the procedure of choice except in a very few cases. Gun barrel fistula in this series of cases has not reduced mortality.

Factors in the high mortality of gun barrel fistula were: (1) infection of the abdominal wound and peritoneum; (2) digestion of abdominal wall; (3) secondary operations necessary for closure.

In addition, the patients in whom the gangrenous loop was in the first portion of the bowel became exhausted and emaciated from loss of intestinal contents; hence secondary closure was rendered very dangerous. Of the 12 deaths following gun barrel fistula, 5 were in frankly hopeless cases. Nine cases were apparently not more serious than those resected with an anastomosis, yet there were only 2 recoveries. Two of the 7 deaths in those cases, in patients not moribund, followed attempts at closure of the fistula; 1 patient died with findings of pneumonia. The other deaths were, as nearly as could be ascertained from the records, of the usual type occurring in late obstruction.

TABLE IV.—MORTALITY, PATHOLOGY, PROCEDURE

	Cases	Deaths	Mortality per cent
Entire series	241	103	42.7
Obstruction without gangrene	175	50	28.5
1. Freeing of adhesions or reduction of obstruction, bowel not opened	149	32	21
a. Lateral anastomosis around the obstruction	14	2	
2. Obstruction without gangrene in which the obstruction was relieved and drainage of the bowel of some type done	26	19	73
a. Drainage of bowel with closure	10	6	
b. Obstruction relieved and enterostomy (Ileostomy, 5 cases; jejunostomy, 1 case)	6	4	
c. Accidental perforation of bowel	6	6	
d. Removal of gall stone from bowel	1	1	
e. Colostomy without removal of adhesion	1*		
f. Cæcostomy with freeing of adhesions	1	1	
g. Colostomy with freeing of adhesions	1	1	
Obstruction with gangrene	42	31	73.8
1. Resection and anastomosis	18	10	55
2. Exteriorization or gun barrel fistula	14	12	85
3. Moribund—died on table—no procedure attempted—etc. (In no case was the gangrenous bowel removed.)	8	8	
4. Localized gangrene due to band with invagination of gangrenous segment	2	1	

*Recovery.

PATHOLOGY AND CAUSE OF DEATH

The clinical facts in this series of cases are explained best on a mechanical basis. Death results from damage to the bowel wall due to distention and strangulation. The exact manner in which death occurs is still in doubt, but the pertinent and essential facts are that it follows decreased viability of the bowel. Dragstedt has shown the importance of the factor of infection in a closed loop and many patients die with perforation of a gangrenous segment and general peritonitis. The necrotic loop may be toxic in itself when exposed to the absorptive properties of the peritoneum. Wangensteen has shown that in experimental obstruction there is very little absorption from the obstructed bowel and that the contents proximal to the obstruction are not more toxic than the contents distal to the obstruction. Toxicity from release of the contents of an obstructed loop into the bowel distal to the obstruction was not observed in this series.

Much has been written about sodium chloride loss as an important factor in causing death from acute mechanical obstruction. In accordance with this theory administration of hypertonic saline has been advocated. Experimentally, loss of chlorides has been shown to be a more important factor in high obstruction. Hypertonic saline has not been given in a sufficient number of cases in this series to warrant an opinion as to its usefulness, but we wish to point out that in 95 per cent of 147 cases the location of the obstruction was in the ileum, or lower. Moreover, while adequate amounts of physiological salt solution have been given in most of these cases after they entered the hospital, we are impressed with the relation of mortality to evidences of actual damage to the bowel. In so called simple obstruction, mortality increased with distention and with the absence of peristalsis; and the usual sequence of events if operation is delayed is distention, absence of peristalsis, impaired viability of the intestine, with all the characteristic findings of peritonitis developing, and death. In addition to the clinical evidence of these facts, the following postmortem records are further evidence of their accuracy.

Autopsy findings are noted in 11 cases. Two cases were not operated upon. Both had a fibrinous peritonitis without actual gangrene. In 1 case there was also a lung abscess and pneumonia. Five cases at operation showed varying degrees of distention and congestion of the bowel. In all 5, release of the obstruction was the only operative procedure. In 3 a diffuse peritonitis was found; in 1 bronchopneumonia; and in 1 pulmonary embolism. In 3 cases intestinal anastomosis was done at operation and at postmortem examination a diffuse peritonitis was found. In 1 case a massive gangrene with numerous adhesions was found at operation and no procedure attempted. The postmortem examination showed a mesenteric thrombosis. While definite conclusions cannot be drawn from such a small number of cases, yet these few autopsy records emphasize that actual damage of the bowel is the primary cause of death in intestinal obstruction.

From a study of these cases, it seems that the essential factor in lowering the mortality of acute mechanical intestinal obstruction is the prevention of damage to the intestine from distention and the pressure of strangulation. Here once more applies the oft-repeated exhortation to early diagnosis and prompt surgery—and may we add a word for the importance of skillful technique.

The measures which failed to emphasize or have allowed one to forget these needs have not produced results.

CONCLUSIONS

1. Enterostomy, drainage of the bowel, and gun barrel fistula have not reduced mortality in this series of cases; as a matter of fact, those treated by these procedures show a very high mortality. We believe that a fistula, while it does have merits in certain cases, must be justified by careful consideration of the entire case before it is performed. Otherwise, it may increase instead of decrease the chances of death.

2. Simple obstruction without actual gangrene, when delay has resulted in marked distention and absence of peristalsis, gives physical findings and mortality similar to that of gangrene due to strangulation.

3. The classification of obstruction into the strangulation type with gangrene and simple obstruction is difficult clinically, and dangerous if it leads to delay in surgery.

4. Distinction between partial obstruction and complete obstruction is also difficult to make and delay in operating for partial obstruction leads to marked increase in mortality.

5. Many cases of obstruction occur from causes not apparent from the patient's history and physical findings.

6. We believe that an adequate enterostomy proximal to the resection of an obstructed and injured area will prove to be of great value.

7. Clinical study and autopsy findings show that mechanical damage to the intestine from distention and strangulation, causing gangrene and peritonitis, or peritonitis before the development of actual gangrene, is the usual primary cause of death in acute mechanical intestinal obstruction. However, in addition to these pathological changes, one must never lose sight of the marked dehydration which is uniformly present in all cases of obstruction; in our opinion, the restoration of the body fluids with isotonic salt solutions, when administered by intravenous and subcutaneous methods, is a life saving procedure.

BIBLIOGRAPHY

1. Bower, G. O., and Clark, Jefferson. Perfringens anti-toxin—preliminary report based on treatment of 25 cases. Am. J. M. Sc., 1928, 176:97.
2. Brill. Surgical mortality of intestinal obstruction—analysis of 124 cases operated on at hospital of University of Pennsylvania. Ann. Surg., 1929, 89:541–548.
3. Burget, G. E., Martsloff, K., and Suckow, G. Relation of intra-loop pressure to condition of animal. Arch. Surg., 1930, 21:829.
4. Codman, E. A. Boston M. & S. J., 1920, 182:420–421; 451; 458.
5. Coleman, E. P. J. Am. M. Ass., 1927, 88:1060–1062.
6. Copher, G. H., Stone, C. S., and Hildreth, H. R. Use of Bacillus Welchii (perfringens) antitoxin in experimental general peritonitis and intestinal obstruction. Ann. Surg., 1929, 89:461–657.
7. Corry, D. C. Treatment of advanced cases of intestinal obstruction or strangulation. Brit. M. J., 1931, Feb. 7.
8. Deaver, J. B. Intestinal obstruction. Ann. Surg., 1926, 83:571–582.
9. Dragstedt, C. A., Lang, and Millet. Relative effects of distention on different portions of the intestine. Arch. Surg., 1929, 18:2257.
10. Eisberg, Harry B. On the viability of the intestine in intestinal obstruction. Ann. Surg., 1925, 81:926.
11. Idem. Experimental intestinal obstruction. Ann. Surg., 1921, 74:584–609.
12. Ellis, J. W. Cause of death in high intestinal obstruction. Ann. Surg., 1922, 75:429–448.
13. Gatch, W. D., Trusler, H. M., and Ayres, K. D. Causes of death in acute intestinal obstruction. Surg., Gynec. & Obst., 1928, 46:332.
14. Gerard, R. W. Lethal agent in acute intestinal obstruction. J. Am. M. Ass., 1922, 79:1581.
15. Haden and Orr. Reducing the surgical risk in acute intestinal obstruction. Am. J. Surg., 1925, Oct.
16. Idem. Treatment of acute intestinal obstruction. Ann. Surg., 1929, 89:354.
17. Hartwell and Cooper. Intestinal obstruction. Lewis Surgery.
18. Hartwell, J. A., and Hoguet, J. P. Experimental intestinal obstruction in dogs with especial reference to cause of death and treatment by large amounts of normal salt solution. J. Am. M. Ass., 1912, 59: 82.
19. Hausler and Foster. Studies on acute intestinal obstruction; simple obstruction. Arch. Int. Med., 1925, 26:31.
20. McKenna, C. Hugh. Acute intestinal obstruction with special reference to ileus following operation. J. Am. M. Ass., 1923, June 9.
21. Idem. Drainage of the upper intestinal loop for the relief of ileus. Surg., Gynec. & Obst., 1913, 17: 674–681.
22. McVicar, C. S. Discussion of the clinical and laboratory clinical findings in certain cases of obstruction in the upper gastro-intestinal tract. Am. J. M. Sc., 1925, 169:224–235.
23. McVicar, Charles, S., and Weir, James F. Nature and treatment of toxemia of intestinal obstruction and ileus. J. Am. M. Ass., 1929, 92:11.
24. Miller, C. J. Study of 343 surgical cases of intestinal obstruction. Ann. Surg., 1929, 89:91.
25. Murphy, F. T., and Brooks, B. Intestinal obstruction: an experimental study of the causes of symptoms and death. Arch. Int. Med., 1915, 15:392–412.
26. Ochsner, Alton. Acute intestinal obstruction. Surg., Gynec. & Obst., 1931, 52:702–712.
27. Owings, J. C., and McIntosh, A. C. Perfringens antitoxin and experimental intestinal obstruction. Arch. Surg., 1929, 18:2237–2245.
28. Scholefield, B. G. Acute internal obstruction. Guy's Hosp. Rep., 1927, 77:160–183.
29. Smithies, Frank. Acute intestinal obstruction. J. Am. M. Ass., 1930, 95:1899.
30. Stone, H. B. Clinical application of experimental studies in intestinal obstruction. Am. J. Surg., 1926, 1:282.

31. STONE, H. B., BERNHEIM, B. M., and WHIPPLE, G. H. Intestinal obstruction: study of toxic factors. Bull. Johns Hopkins Hosp., 1912, 23:159–165.
32. SUMMERS, JOHN E. Surg., Gynec. & Obst., 1921, 32:412–414.
33. TUTTLE, H. K. Mortality of intestinal obstruction: 150 cases coming to operation or autopsy. Boston M. & S. J., 1925, 192:791–795.
34. WANGENSTEEN, O. H., and CHUNN, S. S. Studies in intestinal obstruction: comparison of toxicity of normal and obstructed intestinal content. Arch. Surg., 1928, 16:606–614.
35. Idem. Arch. Surg., 1928, 16:1089–1111.
36. Idem. Simple obstruction: study in the cause of death in mechanical obstruction of upper intestine. Arch. Surg., 1928, 16:1242–1255.
37. WANGENSTEEN, O. H., and GOEHL, REINHOLD O. Evaluation of the expulsion of enemas as a criterion of intestinal obstruction. Arch. Int. Med., 1930, 46:660.
38. WILLIAMS, B. W. Importance of toxæmia due to anaerobic organisms in acute intestinal obstruction and peritonitis. Lancet, 1927, Apr. 30.
39. WILLIS, BYRD C. Diagnosis and treatment of acute intestinal obstruction involving the small intestine. Am. J. Surg., 1930, 8:33.

SPONTANEOUS RUPTURE OF THE COMMON BILE DUCT

A Sequel of Choledochostomy

WILLIAM L. WOLFSON, M.D., F.A.C.S., and DAVID R. LEVINE, M.D., Brooklyn, New York

RUPTURE of the common bile duct is an unusual accident. Either it is caused by trauma or it is spontaneous in origin, the trauma being the usual cause.

It has become increasingly frequent to interrogate the common bile duct by the direct method of incision and probing to obtain accurate information from within the channel, rather than to rely entirely upon an appraising eye or a palpating finger examining the outside layer and wall of the main biliary tube. Owing probably to the more numerous searches and intubations of the duct, we have had occasion to deal with 3 instances of duct rupture in the past 4 years. They have all followed choledochostomy. Our experience with the first case enabled us to make a pre-operative diagnosis in the 2 other cases.

The cases are reported in some detail because they depict a distinct clinical entity which may be recognized. We also offer a few suggestions that may help to prevent this grave complication.

REPORT OF CASES

Case 1. I. F., aged 55 years, white female, had frequent attacks of gall-stone colic beginning 35 years ago. A gall bladder with calculi was removed 25 years ago. Following the operation, the pain recurred as before. During a very severe seizure of biliary colic associated with jaundice, the patient was admitted to the hospital and operated on (June 3, 1933). A choledochostomy was performed, a number of calculi in the common duct were removed, and a T-tube was inserted. The postoperative course was uneventful: the jaundice cleared rapidly, and the tube was removed on the twenty-fourth day after operation (June 27, 1933).

The patient was home and well for 10 days, when she had an attack of cramp-like pains in the abdomen radiating slightly to the right of the interscapular region, associated with epigastric distress, belching, and rectal tenesmus, but without vomiting. This attack lasted for 3 hours. Following this episode, there was another seizure several days later, which was more severe and of longer duration. This was accompanied by marked abdominal distention and regurgitation. The stools were large and foul smelling. One week following this second attack, the woman again suffered from excruciating cramp-like pains in the epigastrium, radiating to the right side and associated with nausea and vomiting. She was then immediately re-admitted to the hospital (July 28, 1933).

Physical examination on admission. The patient was acutely ill, prostrated, icteric, with a marked malar flush. The tongue was dry, the abdomen rigid. There was a sense of fullness in the right side of the abdomen with exquisite tenderness at the level of the umbilicus on that side. No fluid wave or shifting dullness was demonstrable. White blood count, 10,000 leucocytes per cubic millimeter of blood with 78 per cent polymorphonuclears. The urine showed albumin, graded 3 plus, red blood cells, and granular casts. Temperature was 103 degrees F. The pulse rate was 100 per minute. Respirations were 32 per minute. An operation, with spinal anæsthesia, disclosed an abdominal cavity filled with foul smelling, bloody, biliary fluid which contained shreds of necrotic tissue. After the fluid was aspirated, a rupture of the common bile duct was visualized. Intraductal calculi were felt, but the condition of the patient precluded any attempt to remove them at the time. Three Penrose drains were inserted into the subhepatic area. The postoperative course was uneventful until August 14, when the patient had another attack of pain. A few months later, she was operated upon again for relief of common duct obstruction, and the calculi felt at the previous operation were removed. This time a drainage T-tube was left *in situ* for 7 months.

It is of interest that this patient was operated upon 2 years later for a perforating juxtapyloric ulcer, for which a gastrectomy was performed. No ulcer was present at any of the previous operations.

Case 2. R. B., aged 26 years, white female, gave a history of numerous attacks of biliary colic of 4 months' duration. During the last of these attacks she developed jaundice. On May 9, 1933, the operative notes revealed that the gall bladder was chronically inflamed, but non-calculous. The common bile duct was dilated and contained a cast of thick mucoid material. A cholecystectomy was performed, followed by a choledochostomy, a straight rubber catheter being used for drainage. The postoperative course was uneventful, and the tube was removed on the eleventh postoperative day. The external wound was closed by June 7. Four days later, the patient experienced a sudden attack of pain in the abdomen and back, and vomited undigested food. There was no constipation. Following this seizure, she was re-admitted to the hospital.

Physical examination. There was disclosed a healed upper right rectus scar, and a rigid abdominal wall which was tender throughout. There was impaired resonance with distant breath sounds at both lung bases. Tenderness was definite in the left costovertebral angle. Icterus was noted. The temperature was 102 degrees F. The pulse rate was 108 per minute. Respirations were 22 per minute. White blood count 16,000 leucocytes with 98 per cent polymorphonuclear cells. The urine showed a faint trace of albumin and bile. The blood chemistry was normal. A diagnosis of acute pancreatitis was made and expectant treatment was advised. A roentgenographic study revealed that both diaphragmatic cusps were obliterated by some subdiaphragmatic condition. The temperature mounted to 104 and 105 degrees F. The diagnosis was changed to that of spontaneous rupture of the common bile duct. The abdominal cavity was opened, a local anæsthetic being used, and was found to be filled with bile and pus. When the fluid was suctioned off, a rupture in the common bile duct was disclosed. Three cigarette drains were placed in the region of the duct and in Morrison's fossa. The postoperative temperature rose to 107 and 108 degrees F. The patient was given transfusions, stimulants, and parenteral fluids, but despite these measures, she died the next day. The culture of the peritoneal fluid showed Bacillus coli. No necropsy was obtained.

Case 3. P. G., aged 42 years, white female, had suffered from biliary colic for 1 year. At times the accompanying

icterus was intense. During an operation on June 19, 1933, a small contracted gall bladder was visualized. The common bile duct was markedly dilated and contained calculi. A choledochostomy was performed with a drainage T-tube. The gall bladder was undisturbed. The postoperative course was uneventful except for a low febrile trend during the first 11 days. The tube was removed 2 weeks postoperatively, and the wound healed.

She was re-admitted on August 31, 1933, with a 2 day history of pain in the upper abdomen associated with fever and jaundice.

Physical examination on admission. The patient was acutely ill, with the right upper quadrant of the abdomen tender and rigid, a healed scar in this area, a mild icterus, and moderate abdominal distention. The temperature was 101 degrees F. The pulse rate was 106 per minute. Respirations were 20 per minute. A diagnosis of spontaneous rupture of the common bile duct was made, and an operation was immediately performed under a local anæsthetic. When the peritoneum was opened, a large amount of blackish-brown biliary fluid was disclosed. This was suctioned off. The patient's condition contraindicated any further surgical manipulation. Three cigarette drains and 1 gauze drain were inserted. The patient had a stormy postoperative course for the first 3 days, and then made a rapid and complete recovery.

A careful review of the literature has failed to reveal reports of similar cases, but they may be recorded under obscure or indefinite headings. From a critical study of these cases, one is impressed by certain striking and definite characteristics. In brief, the syndrome may be reconstructed in this fashion: A patient with a long history of biliary colic, who may or may not have had a previous cholecystectomy, enters the hospital with definite evidence of common bile duct obstruction. The obstruction is relieved, the proof of patency of the duct is established, a choledochostomy is performed, and the patient recovers satisfactorily. After a time, the tube is removed, and the draining sinus finally closes. Suddenly, the patient is seized with upper abdominal pains, vomits, becomes distended, is febrile, has a coppery-red malar flush, is icteric, and prostrated. Rigidity and tenderness develop in the upper abdomen. Leucocytosis and polynucleosis are present. The abdominal cavity is re-opened, and is found to contain a tremendous amount of admixed biliary fluid.

Acute pancreatitis is the condition most likely to be confused with this syndrome. If it is realized that a spontaneous rupture of the common bile duct may follow choledochostomies, an immediate abdominal operation will be performed instead of instituting any expectant treatment.

The etiology of the spontaneous rupture of the common bile duct is probably a subacute infectious process at the site of the choledochostomy. With the drainage tube *in situ*, this process is adequately protected. However, when the tube is removed and the common bile duct begins to heal, the granulations are soft and friable, and the exudate covering weak and insecure. Any undue strain on the wall of the duct at this point, because of increased pressure, may cause a rupture. Once the bile escapes into the peritoneal cavity, a widespread peritonitis may develop. That bile causes such a reaction has been proved by many investigators. There is also the possibility that many of the localized subhepatic pools that follow common duct intubations have resulted from a rupture of the duct, the collection being walled off from the general peritoneal cavity.

To prevent such a sequel to choledochostomy, we advocate that the T-tube or rubber catheter, when removed, be replaced by a straight rubber tube of the same diameter into the original sinus. This tube is to remain for a long period of time so that effective removal of all infectious material may be maintained until the duct is given adequate opportunity to repair solidly the damage done by the trauma of the operation and the pathological process.

SUMMARY

1. Three cases of spontaneous rupture of the common bile duct are reported following choledochostomy.

2. The diagnosis may be made before operation by the recognition of this definite clinical entity.

3. Immediate operation under local anæsthesia is indicated.

4. The etiology of this complication of choledochostomy is discussed.

5. A means of prevention is suggested.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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MARCH, 1935

CONGENITAL CYSTS AND FISTULÆ OF THE NECK

THE study of congenital cysts and fistulæ of the neck is of great interest from an embryological standpoint; a knowledge of their development affords the surgeon not only an exact map for the field of action but also an understanding of the many intricate, fascinating, and rapid transformations of organic anlagen so that he is better able to cope with such tumors. In the main congenital cysts and fistulæ of the neck are divided into two groups, median and lateral.

The median cysts and fistulæ have been recognized as having the course of the anlage of the thyroid which was discovered by His who found that in its course through the tongue this tract was always a solid cord, never a tube with a lumen. At times high columnar, and again pavement cell epithelium was found in the persistent thyroglossal duct and for the most part there were several parallel ducts with much lymphoid tissue around them and clusters of acinous glands. This did not conform with a thyroid tissue origin. Were these larger ducts formed by such acinous glandular material? The epithelium is of such different appearance that this origin can be readily excluded. In early stages of the thyroid anlage we see a comparatively large lingual duct, the channel which leads from the foramen cæcum into the tongue and from the bottom of which the thyroid anlage develops. This lingual duct is not only relatively large but it has in addition branches which run in part parallel to the main channel. Even in the normal adult the channel leading from the foramen cæcum varies considerably in length. It is rather probable therefore that the thyroglossal duct is an abnormally long and persistent lingual duct. It has been argued that thyroglossal duct fistulæ never have an opening into the foramen cæcum. This is not correct, however. It is true that a probe inserted into the fistulous tract is arrested chiefly at the hyoid bone; but this is due to a kinking or to a local obliteration which very often occurs at this point. The hyoid receives cartilaginous form in the beginning of the fifth week of embryonal life when the normal thyroglossal tract has vanished. If a "duct" persists at that time, the hyoid may develop behind it, which is the most frequent happening, or it may include the channel, or in rare cases may develop in front of the duct. Very frequently the duct is kinked off or entirely obliterated at this point. However, in some cases the whole channel could be injected. Takeda could inject the fistula even from the foramen cæcum and found that the injected fluid appeared in drops from the outer fistulous opening. The lymphoid tissue and the clusters of mucous glands accompanying the duct lumina can be

explained as having been drawn along from the surface. The great mass of lymphoid tissue at the base of the tongue, called lingual tonsil, reaches anteriorly to the foramen cæcum. A thyroglossal duct which is still present in later life is probably the result of an abnormally long and persistent lingual duct which was drawn downward in the fourth week of embryonal life by the very rapid descent of the thyroid anlage. In the majority of the cases, fistulæ are caused in postnatal life by perforation of a pre-existing cyst. An adenoma or a carcinoma may develop from an embryonal inclusion such as described and for this reason it will be worth while to study and make note of the exact site of the earliest beginning of a carcinoma of the base of the tongue; some of them have been found to have originated at the foramen cæcum.

The lateral congenital fistulæ are not as readily and as definitely understood as to origin as are the median ones. In the lateral fistulæ several embryonal structures are possible sources.

The second branchial cleft and pouch were thought to have a part in the formation of lateral fistulæ. This assumption was based on Rabl's demonstration at this location of a very long and narrow channel-like formation (Rabl's duct). The assumption that lateral fistulæ originated exclusively from the second gill cleft was not accepted by other students of embryology. They believed that the other clefts, not the second alone, might be the cause of such cysts and fistulæ. Then, in 1912, Wenglowski, after a thorough study of a large amount of material, published a report in which he concluded that the thymopharyngeal duct, because of the persistence and elongation of the primary thymus anlage which contains a vesicle, was the sole structure responsible for the production of lateral cysts and fistulæ. The thymus is a derivative of the third pharyngeal pouch. This view prevailed for a long time and undoubtedly in many cases, perhaps even in the great majority, the condition was brought about by such factors. This viewpoint did not remain unchallenged, however, for in 1927 Nylander published an account of his embryological research which led him to contradict Wenglowski's views inasmuch as he did not believe Rabl's decision was applicable in all cases. Nylander claimed that even the majority of the lateral cysts and fistulæ were due to a persistence of Rabl's duct. The surgeon can decide promptly in a given case whether he is dealing with one or the other variety of fistulæ; this is possible through his knowledge of the relation of the channel to the carotid vessels. In early embryonal life the external carotid runs straight upward from the common carotid, both vessels lying in front and mesial to the branchial apparatus. The internal carotid is the axis of the third branchial arch which it traverses from in front backward. Any evagination from the second pharyngeal pouch traverses therefore the space between the internal and external carotids, the internal carotid lying posterior, the external anterior to the fistulous tract. If the fistula involved is of the thymopharyngeal duct type, the tract must lead around the outer side of both carotids because the thymus originates from the pouch underneath the third arch. Future exact observations will have to be made to determine the relative frequency of the two origins mentioned. At present the question is still *sub judice*.

In a field in which rapid transformations take place as in the branchial apparatus with its derivatives, many diverse embryonal inclusions are very possible; indeed, several rare isolated cases of fistulæ or cysts from other sources are described in the literature.

Embryonal epithelial remnants, according to Cohnheim's theory are a source of neoplasms,

and in the branchial apparatus may give rise particularly to adenoma and carcinoma. A branchiogenous carcinoma of the neck near the bifurcation of the common carotid is not very infrequent. As in cases of carcinoma of the base of the tongue, it will be of interest to investigate, wherever possible, the exact location of the first appearance of the carcinomata of the tonsillar lodge. They are not so very rare and some of them may be due to a remnant of the lateral structures mentioned.

ARNOLD SCHWYZER.

SURGICAL SHOCK

THE modern tendency in surgery is to classify all forms of acute circulatory failure complicating operations and wounds, except organic heart failure, under the head of "shock." The causes may be grouped under three general heads, namely: disturbances in vascular tone, disturbances in blood volume, and disturbances of tissues and tissue fluids. The importance of the first two has long been known, but that of the last has come to light only in more recent years.

Disturbances in vascular tone are brought about mainly through the nervous system. There is much uncertainty as to the rôle which they play in the production of surgical shock. Pure psychogenic disturbances may produce marked lowering of blood pressure as seen in ordinary syncope, which shows many of the features of the shock syndrome. The systolic blood pressure may drop to as low as 50 or 60 millimeters mercury and slight bradycardia develop with resulting unconsciousness, but the reaction is, as a rule, of short duration. If a severe wound, resulting in pain and loss of blood, is accompanied by such a psychic reaction, it greatly increases the likelihood of the development of a prolonged state of circulatory depression and may lead to shock. Afferent impulses resulting from nerve stimulation from wounds and operations have long been held to precipitate shock independent of psychic action by directly influencing the vasomotor centers with consequent lowering of blood pressure. The mode of action has been variously interpreted as an exhaustion of the medullary vasoconstrictor center, reflex inhibition of the vasoconstrictor center, or stimulation of the medullary vasodilator center, and there is as yet no unanimity of opinion.

Neurogenic fall of blood pressure is most definitely seen in connection with operations on the abdomen especially on the stomach and gall bladder in which it occurs in approximately 10 per cent of the cases. The anæsthetic may be either local or general. The blood pressure falls during the early part of the operation and in the absence of hæmorrhage. The various pathways of the causative afferent impulses that have been considered are the vagi, the splanchnics, the upper lumbar sympathetics, and the intercostoabdominal nerve roots. The reaction has been most frequently attributed to the vagus, but there are important objections to this theory, especially since it is impossible to reproduce the condition by all types of stimulation of vagus fibers beneath the diaphragm. There is an accompanying mild bradycardia but the respirations show little change. The reaction passes off as the intra-abdominal operation is completed and has usually disappeared by the time the abdomen is sutured. Ordinarily it does no damage to the patient and unless blood pressure readings are taken the anæsthetist and the surgeon may be unaware of its intensity. If the operation is prolonged and complicated by other shock producing occurrences, as hæmorrhage, it may assist in leading to a marked state of shock. Ephedrine usually causes its prompt disappearance and should be given if the reaction is prolonged.

There is much uncertainty as to whether or not stimulation of the large nerve trunks in other parts of the body ever causes a marked fall in blood pressure when psychic influences are eliminated. Cutting and pinching nerves at operation and electrical tetanization of nerves in experimental animals results in a rise rather than a fall of blood pressure. However, in cases of extreme injury and prolonged and extensive cutting operations where a number of blood pressure lowering factors may be active, it is often impossible to exclude afferent sensory impulses as a contributing agent.

Hyperactivity of the sympatho-adrenal system resulting in prolonged arterial spasm has been considered as one of the causes of shock, and the recent work of Cannon and Freeman supports this view. The eventual effect of the vasoconstriction is to damage the capillaries, increase their permeability, concentrate the blood, and reduce the circulating blood volume. More clinical evidence is needed for acceptance of the view that this is an important cause of surgical shock.

Loss of blood is, of course, the most important cause of acute circulatory failure and its significance is too well known to warrant discussion here. Suffice it to say that failure to recognize the extent of internal and even external hæmorrhage often leads to the erroneous assumption that other factors are responsible for the state of shock. Loss of blood and psychogenic and neurogenic reactions are the three conditions that may bring about rapid fall in blood pressure with the accompanying picture of shock. However, a patient with a tumor of the adrenal medulla (theochromocytoma) may be thrown into a critical state of high blood pressure and rapid pulse presumably from hyperadrenalinæmia by an operation or injury (as a fracture of the hip recently observed) with a fall in blood pressure before the death.

Recent studies have shown that loss of plasma as by experimental plasmapharesis results in reduction of circulating blood volume, concentration, and stagnation of erythrocytes and a gradual fall in blood pressure with accompanying manifestations of shock. Blalock showed that sufficient plasma may be lost from manipulation of the intestines of dogs to create shock, but such an occurrence is rarely a complication of operations on man.

Alterations of the tissues and tissue fluids, as a result of local injury or constriction of the circulation may lead to a state of secondary shock. The cause has been considered by some to be a toxin formed in the damaged tissues which enters the blood stream and produces general toxic symptoms. The toxic agent was thought to be histamine or a histamine-like substance in the case of both wounds and limb constriction. Recent experimental investigations have failed to show the presence of a toxic substance in the damaged tissues or circulating in the blood following either trauma or limb constriction. This does not exclude the possibility of the existence of traumatic toxæmia. However, these investigations have also shown that as a result of extensive wounds there is escape of plasma or blood, or a combination of the two, into the tissues in quantities sufficient to create a state of shock. In some cases the blood vessels may be torn and hæmorrhage may be the main cause of circulatory failure. If the limb is traumatized without tearing vessels, the main cause is extravasation of plasma with a resultant blood concentration. The fluid producing the swelling in traumatized limbs has been found to contain as much as 5 per cent of plasma proteins. Prolonged limb constriction results in increased permeability of capillaries and following release, the part swells markedly from the escape of plasma into the damaged tissues. This dislocation of plasma

proteins may result in impairment of circulation and shock that proves fatal before signs of gangrene have had time to develop. Burns and freezing have been demonstrated to produce circulatory failure in the same way. Plasma proteins are gradually poured out into the damaged tissues in such quantities that marked blood concentration and reduction in circulating blood volume are brought about, explaining the state of shock which may develop without the assumption of the formation of toxic substances.

Swingle and co-workers have reported that deficiency of adrenal cortex hormone results in increased permeability of capillaries and loss of plasma with blood concentration and serious reduction in circulating blood volume. They assume that this plays a rôle in surgical shock but clinical studies are wanting for substantiation of the view. Prolonged low blood pressure from any cause increases capillary permeability with loss of plasma and eventually of erythrocytes with irreparable damage. Blalock has recently shown that this holds for hæmorrhage and that after blood pressure has been low from this cause for three or more hours abundant blood transfusion fails to arrest the escape of plasma and blood and to rehabilitate the circulation.

Clinical experience has shown that as long as permeability has not been seriously damaged, low blood pressures usually respond to fluid administration—best to blood transfusion, but also well to physiological salt solution. But when the permeability has become too great, whether from nervous influences, hæmorrhage, local trauma, prolonged constriction, burns, or freezing, the administration of fluids serves to increase the amount of plasma poured out of the circulation, either locally or generally, or both, and a fatal termination is the almost inevitable result.

D. B. PHEMISTER

EARLY AMERICAN HOSPITALS

THE WOMEN AND CHILDREN'S HOSPITAL

BEULAH CUSHMAN, B.S., M.D., CHICAGO, ILLINOIS

TO write the history of the Women and Children's Hospital, one must go back farther than the day when the doors first opened on the modest little dispensary and hospital that has gradually grown to an organization of its present size. One must go back to 1829, to the birth of Doctor Mary Thompson, who as a pioneer woman in medicine, organized the small unit to serve the immediate needs of women and children more or less destitute following the Civil War. She dreamed dreams as she worked tirelessly to realize her ambition—dreams that were kept alive, in spite of many trials, finally to materialize into the present organization.

Doctor Mary Thompson was born in New York State, was educated in the East, and came to Chicago in 1863. She had been preceded by two women who had made an unsuccessful attempt to found a dispensary for women and children, but their plans had been abandoned. At the time Doctor Thompson came to Chicago there were two hospitals in the city. Neither permitted women physicians to utilize their facilities and one did not accept women patients. At this time the Civil War was at its height. Medical facilities were limited for those not actually engaged in the war, since most of the physicians had been enlisted for services on the battlefield. Drugs were difficult to obtain, and few people had the money to pay for them. Friends of Doctor Thompson appealed to her to help alleviate the suffering of the women and children of the city as well as of the many people who had migrated to Chicago from the East. She organized a dispensary and arranged with a group of druggists to provide medicine at reduced prices. Many of these patients, however, were unable to benefit by the medical advice and care that she could provide because they in some cases had long distances to travel to and from the dispensary and were not in physical condition to stand the strain. Out of this pressing need, in the winter of 1864–65, the plans for the founding of a new hospital were formed. On May 8, 1865, a building situated at Rush and Indiana Avenue, was opened. It provided 14 hospital beds, a dispensary, and a drug room. During this first year the hospital treated 203 patients. The charge was presumably five dollars a week, but it is recorded that out of the 203 patients only one patient paid in full for her care.

In its second year the hospital had already outgrown its facilities and was therefore moved to a residence at 212 Ohio Street. It was while located here that the hospital met its first opposition. A petition was filed against it as a "nuisance." The original incentive for this move seemed to be that a man wished to rent for a stable the barn of the residence, which was serving at the time as a laundry for the hospital. The

The Women and Children's Hospital

Proposed plan for new hospital

charge was investigated, the health department reported that the laundry was "clean and healthy," and the institution was allowed to continue.

Three years later the hospital again needed larger quarters, and this time it was established at 402 N. State Street. It remained there until 1871, when unfortunately the hospital was one of the victims of the great Chicago fire. In 5 minutes, according to one dramatic report, the building was burned to the ground. The patients were transferred to another house, but they were soon again forced to leave because the fire had spread. All of the material assets of the hospital were wiped out save for two pillows, a blanket, and a piece of carpet.

With these "remnants," at the instance of the late F. B. Gardner, Mrs. W. G. Dyas, and other interested friends, a vacant house was taken at 598 West Adams Street, which was soon carpeted with mattresses and patients from attic to basement. No bedsteads could be had at the time. Here helpless women and children, suffering from general sickness induced by fright, exposure to excessive fatigue and fire, followed by cold rains, were given food and medicine. On the 23rd of December, 1871, the Hospital was moved by the Aid and Relief Society to the Barracks on Throop and Harrison Streets. When the demands produced by the fire had ceased, it moved in April, 1872, to 157 Center Avenue, where it remained until the opening of the earlier building at Adams and Paulina Streets, February 26, 1873. In 1873, in acknowledgment of public service, the Relief and Aid Society gave the hospital $25,000.00 with which the site at Adams and Paulina Streets was purchased. The commodious house on this site was transformed into a hospital; the small barn on the rear of the lot being used for the Women's Medical School. In 1873 it founded the first training school for nurses in the middle west. In 1885 the hospital moved into a five story brick and stone building specially planned for it. The new building, at Paulina and Adams Streets, was opened December 10, 1885, and remained the home of the organization until the opening of the present hospital at Ashland and Maypole Avenues in January, 1929, the present building providing facilities for 100 patients.

In glancing through the records of the hospital one finds many interesting little touches that must have been of great significance to the hospital. Food is frequently mentioned, from which we may gather that the endowment of the hospital was so meager that even its immediate needs had to be met by the generosity of friends. Pillow cases, garments for the patients, quilts, and similar equipment were provided by individuals and groups. Material for bandages was provided by gifts of old linen. The Third Presbyterian Church contributed one and a half gallons of wine.

The present hospital is a very different institution from that formulated out of the needs of Chicago during the Civil War. The hospital's staff is composed entirely of women physicians. It offers surgical, medical, and obstetrical care, maintains a well equipped X-ray department, which is adequate not only to aid in diagnosis but also to carry out treatment as indicated. The hospital also operates the third largest dispensary service in the city. The Emergency Welfare Relief provides a fund for the care of 20 hospital patients and 65 dispensary patients a day. The institution sustains a standard of work that makes it acceptable by the American Medical Association for the training of internes. A home for nurses was maintained from 1873 to 1930.

One of the unique branches of the work of the hospital is The Mother's Milk Bureau, organized and established by Dr. Bertha Van Hoosen in 1930. This organization furnishes mother's milk to the hospitals in the city for babies who are undernourished or for some reason do not tolerate the usual artificial formulas. The milk is obtained from mothers who have undergone very complete physical examinations, and whose babies not only are not using all of the milk the mother has, but are also found to be doing well on the mother's milk they are consuming. The donors and their babies are carefully supervised to ascertain that the mother eats properly and that her own baby is not being sacrificed for the financial remuneration the milk brings. The milk is collected with great care, is transported in special iced containers, and is never used if more than 24 hours old. The Bureau distributes about 1500 ounces a month, part of that being given away to families unable to pay for it, for the slogan of the organization promises that no baby in Chicago shall die for lack of mother's milk. This department was founded in 1930 and has its distributing center at the Women and Children's Hospital.

THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

TO us as medical students 20 years ago two textbooks of surgery seemed to stand out from a considerable number of available and popular one volume works because of their conciseness, their clarity of expression, and their stimulating interest. To these, Stewart's *Manual of Surgery* and deQuervain's *Surgical Diagnosis*, has in recent years been added a third,[1] which is the best single volume work covering the field of surgery that we have had the opportunity of reading.

The necessity for a third edition of Homans' *A Textbook of Surgery* only 4 years after its introduction to the medical profession indicates how popular it has become in this short period. Many features contribute to this well deserved popularity: the book is, first of all, an attractive and pleasing example of the book maker's art; the illustrations are well chosen, carefully drawn, and truly illustrative; they do not detract from the subjects concerned by excessive size and needless emphasis on trivial details; the historical sketches which introduce many subjects provide a background which is both interesting and essential to the student who would truly grasp surgical principles and practice; the bibliographical index is exceptionally complete and ingeniously arranged to enable the reader to find quickly the source of the author's material. Finally, and of greatest importance, is the well balanced presentation of the tremendous number of subjects included in general surgery. To have taken the lectures and papers of many different individuals interested in widely separated fields of surgery, to have welded them into a homogeneous whole, to have filled in the many and extensive gaps untouched by the author's associates, to have omitted so wisely the obsolete material that has been allowed to encumber many of the older books, and to have produced finally a thoroughly interesting, readable, and well considered textbook of surgery seems to us an admirable achievement and one that deserves unstinted praise.

With specific reference to the new edition, the publishers list on the inside page of the jacket some thirty subjects "which have undergone correction or been newly introduced in the third edition." "The new material," in the author's prefatory words, "has been incorporated without a change in pagination, under the plan that for everything fresh that comes in something stale must go out." We have not been able to recognize the "stale that has gone out," but have seen many evidences that the author has labored diligently to include in this new edition the worth while contributions of the past few years.

SUMNER L. KOCH.

[1] A TEXTBOOK OF SURGERY. By John Homans, M.D. 3d ed. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1935.

ANY literary work which reaches its fourteenth edition and which has been translated into seven foreign languages has achieved a position of unquestioned importance. May's *Diseases of the Eye*[2] made its first appearance in 1900 and for many years has been probably the most widely used text on the eye for general practitioners and medical students, both in the United States and in several other countries. During the past year the seventh British, the ninth Spanish, the sixth Italian, and the third Chinese editions have been issued.

The secret of this wide universal acceptance has been the fulfillment of the original conception of the author to create a book on the eye not for the ophthalmologist but for the student of medicine and the general practitioner of medicine. Theoretical considerations, detailed discussions and descriptions, and the more unusual ocular conditions are carefully avoided or only briefly mentioned. The language is concise, simple, and explicit. There are many excellent illustrations, including two new colored fundus plates.

Much of the material has been rewritten for this fourteenth edition, in an attempt to eliminate the obsolete practices usually carried along from one edition to another in works of this kind. The newer treatment of retinal detachment has been ably handled and brought up to date; there have been revisions on anatomy, pathology, and ocular motility.

It may be questioned that ophthalmological optics and refraction should be assigned 63 pages in a work of this scope, intended for and used by the man in general medicine and not by the specialist. It is too detailed for the former and insufficient for the latter. Many minor criticisms might be offered on such points as the rôle of the staphylococcus in the production of acute conjunctivitis, the importance of pain as a leading symptom of retrobulbar neuritis, the rather frequent mention of the use of leeches, and similar points not strictly in keeping with modern practice.

The fine points of this book are too numerous for a few faults to outweigh them and with the improvements and revisions of the present edition it should

[2] MANUAL OF THE DISEASES OF THE EYE; FOR STUDENTS AND GENERAL PRACTITIONERS. By Charles H. May, M.D. 14th ed. rev. Baltimore: William Wood & Co., 1934.

continue to occupy first place in popularity among students and practitioners of general medicine.

WILLIAM A. MANN, JR.

THE new edition of *A Textbook of Bacteriology*[1] by Zinsser and Bayne-Jones, is remarkable for the extent to which it has been brought up to date. But even more so is the element of fair judgment with which the authors have evaluated the wide variety of recently published articles.

Even the recent medical graduate who examines this book will find evidence of new and major advances in the subject of bacteriology with definite bearing on clinical medicine. The older graduate will note that a veritable flood has passed under the bridge since his day as student of this science.

The authors have taken a definite forward step in selecting and presenting materials so as to indicate the application of bacteriology and immunology to clinical medicine rather than to present the strictly diagnostic aspect. Yet at the same time they have made available a wealth of information which has been adequately digested and correlated so as to elucidate biological principles.

This book has particular value as a reference volume, giving to its reader information published as late as 1934. The material has been fairly judged by the authors and presented in a manner that makes it readily available. As to its use as a textbook for medical students, one wonders if the average medical curriculum allots to the course in bacteriology sufficient time for the student to cover adequately the essentials in this book.

The chapters on the bacteriology of milk and water have been eliminated, to provide, as stated by the authors in the preface, "space for a presentation of some of the great mass of newly acquired material." One wonders if the time has not come when the chapter on parasitology can be omitted from textbooks of bacteriology and given over to the protozoologist, for parasitology seems in some respects less related to the science of bacteriology than does the bacterial content of milk and water and their sanitary significance.

The recent developments in bacteriology have more prominent place in this book.

The newer infectious diseases, as tularæmia and undulant fever are more extensively described and discussed than usual.

Among the more recently developed and important fields of immunology bearing directly on clinical medicine is that of the soluble specific substances. This subject is adequately handled, as would be expected since the senior author was a pioneer in this field. Bacteriophage therapy is discussed in the light of recent experimental studies, and its value as a therapeutic agent is questioned. More space might have been devoted to the presentation and discussion of the experimental evidence on which the authors based their conclusions, since bacteriophage has been so widely heralded as a panacea in the treatment of infections.

In this book the authors have emphasized the facts and established principles of the science of bacteriology. The unestablished and theoretical has been fully presented and different opinions on controversial subjects presented and controversially discussed.

ARTHUR W. WALKER.

THE recent publication of the fifth edition of Professor Folin's *Laboratory Manual of Biological Chemistry, with Supplement*[2] again brings to date a volume outstanding because of the originality and productivity of its author, whose methods comprise a large part of the contents. The arrangement is the same as in previous editions, the material designed essentially for class instruction being arranged in a series of ten parts dealing with elementary considerations of volumetric analysis, catalysis and enzyme action, fats, carbohydrates, proteins, urine analysis and metabolism, blood, bone, and bile. Wherever possible, quantitative methods of study are presented, there being a minimum of purely qualitative experiments.

The discussion (Part 1) of the essential elements of chemical equilibrium, the proper selection of an indicator for titration and what occurs during the titration of an acid and base, is so clearly and simply presented as to be within the comprehension of any non-mathematical student. One wishes, however, that a few simple experiments had been devised to illustrate the principles discussed. The material contained in Part 5 on proteins is devoted chiefly to color reactions and precipitation tests. In view of the amphoteric nature of protein, it seems to the reviewer that a section devoted to colloidal chemistry, or to a few experiments illustrative of the colloidal behavior of proteins could be added with advantage. An experiment on the isolectric precipitation of protein would acquaint the student with a method in general use in research and industry today. The methods of quantitative urine analysis are introduced in Part 6. Significant changes have been made in the uric acid method which diminishes the interference by polyphenols and other substances. Parts 7 to 10 remain the same as in earlier editions.

Probably the most valuable material of the book is contained in the supplement. The section has undergone the greatest revision. Professor Folin has discussed in detail the various steps in the more complicated procedures of blood and urine analysis where difficulty may be experienced in learning the methods. In the section on urinalysis a tentative colorimetric method for the determination of phenols has been introduced, Lloyd's reagent and oxalic acid being used to remove the interfering uric acid. In the section on blood analysis the use of an unlaked

[1] A TEXTBOOK OF BACTERIOLOGY; WITH A SECTION ON PATHOGENIC PROTOZOA. The Application of Bacteriology and Immunology to the Etiology, Diagnosis, Specific Therapy and Prevention of Infectious Diseases. By Hans Zinsser, M.D., and Stanhope Bayne-Jones, M.D. 7th rev. ed. New York and London: D. Appleton-Century Co., Inc., 1934.

[2] LABORATORY MANUAL OF BIOLOGICAL CHEMISTRY; WITH SUPPLEMENT. By Otto Folin. 5th ed. New York and London: D. Appleton-Century Co., Inc., 1934.

blood filtrate, originally devised for the determination of uric acid, has been extended to the methods for blood sugar, creatinin, and non-protein nitrogen. The author justifies its use in the following statement: "Doubtless there is still room for differences of opinion as to whether indiffusible, fixed materials of the red blood cells should or should not be included in some of the analyses, but the view is taken here that the inclusion of suddenly disintegrated cell materials does not belong in the determination of the levels at which definite well known materials are being transported to and from tissue." New micro-methods, with but 0.2 cubic centimeter blood have been introduced for the estimation of non-protein nitrogen and uric acid, together with the author's well known micro-method for blood sugar, which requires but 0.1 cubic centimeter blood. Explicit directions for the purification of reagents required in these, as well as in other procedures, are given.

As in previous editions, the methods for inorganic constituents of urine and blood devised by Professor Fiske and associates, and for total fatty acids and cholesterol in blood plasma by Professor Bloor, have been incorporated.

Not only does this volume fulfill its purpose as a laboratory manual for medical students, but it is especially valuable to all engaged in routine blood and urine analysis and research. C. J. FARMER.

THE Cancer Control Organization for Edinburgh and Southeast Scotland was inaugurated on March 2, 1934. The purpose of the organization is the investigation, the care, and the control of cancer. The volume reviewed here is the first publication of the new organization and presents a statistical survey of the results of the treatment of cancer in the Royal Infirmary.[1]

The introductory chapter consists of the chairman's address by Mr. J. J. M. Shaw. If this small volume contained nothing more than the chairman's address, its publication would have been fully justified. Those who have attempted to pronounce a brief but comprehensive statement of the cancer problem to a mixed audience fully appreciate the difficulty of this task. Mr. Shaw has accomplished this task admirably. The presentation is clear, concise, and beautifully composed. The point of view is sound and well balanced. No one who is interested in the subject of cancer control should fail to read it.

Three hundred and thirty-three cases of carcinoma of the female breast and one carcinoma of the male breast are analyzed. The radical operation, sometimes combined with radiation, has been the treatment of choice in the operable group. Cancer of the tongue is treated by interstitial radiation.

It is quite evident that one of the important handicaps in the work of this institution is the inadequacy of radium facilities. The radium bomb does not contain sufficient radium to prove an effective instrument. The minimum must be one gram; preferably it should contain two grams.

The publication contains further statistical data and the methods of treatment of other forms of neoplasm. It is quite evident from this publication that this group is making a sound and intelligent effort to execute modern cancer therapy.

MAX CUTLER.

A REMARKABLE book is *Cirugía Gástrica*.[2] The author, Manuel Corachán, is a distinguished professor of surgical pathology in the medical school at Barcelona and chief surgeon to a large hospital. He has had a large clinical material, and one needs only to glance at the extensive and well chosen bibliography scattered throughout the book to see that he has been a tremendous reader. Remarkable for a European is the fact that he is thoroughly conversant with American contributions as well as with those of his own country, France, England, and Germany. The book is beautifully printed on fine paper and it is beautifully bound. It would be a source of lifelong pride to any publisher in the world. The illustrations are many and they are well reproduced.

Particularly remarkable is the lavishness with which good colored photographs have been used. Many of the roentgenographs are particularly interesting because the technique of Berg and others has been used to show the folds of the gastric mucosa.

It is unfortunate that so few American surgeons read Spanish, for there is much in this book to interest and help them. Actually, there is no book in English covering the field so extensively or so beautifully as this volume and its companion will do.

A large part of the book is taken up with hints on the examination of the patient. There is much valuable material also on the anatomy, physiology, and pathology of the stomach. There are beautiful colored representations of what can be seen through the gastroscope.

Much space is given, as one would expect, to the problems of ulcer and cancer. In addition, many pages are given to the discussion of the rarer lesions of the stomach.

The author gives more space to problems of gastritis and gastroptosis than most American surgeons would give. So far as operating for ptosis goes, he points out wisely that even if an operation is done, the patient must be treated medically for a long time, with rest and an over-feeding diet.

About the only criticism that one might make after reading here and there through the book is that the author might well have trusted more to his own experience and wisdom and less to his extensive knowledge of what others have written. The physician or surgeon looking for help is grateful to the man who has prepared a good review or abstract of the literature, but often he is even more grateful for frank statements by a man of wide experience.

[1] CANCER—EDINBURGH 1934. Published by The Cancer Control Organization for Edinburgh and Southeast Scotland. Edinburgh: E. & S. Livingstone, 1934.

[2] CIRUGÍA GÁSTRICA. By Dr. Manuel Corachán. Vol. i. Barcelona Salvat Editores, 1934. (775 pages.)

The second volume is to contain chapters on preoperative and postoperative care, anæsthesia, indications for, and technique of, the various operations on the stomach, rare or disused operations, the stomach that has been operated on, the results of the various operations, and the bad results sometimes obtained after gastro-enterostomy and gastrectomy.

CHARLES H. MAYO.
WALTER C. ALVAREZ.

THE volume[1] entitled *Foreign Body in Air and Food Passages* by Drs. Chevalier and C. L. Jackson has long been awaited both by the roentgenologist and endoscopist and neither will be disappointed as it fulfills all pre-publication expectations. Coming from the pen of the Jacksons it is quite natural and necessary for it to be simple and lucid yet complete in every detail.

The book falls into eight main sections devoted chiefly to differential diagnosis of both radiopaque and radioparent foreign bodies from an X-ray standpoint although the associated pathology is not neglected. Accompanied by 150 X-ray reproductions with descriptive legend of all types of cases there is very little if anything overlooked. Thus it is very easy to follow the authors through the description of a drowned lung as compared to a pulmonary abscess, or what the roentgenologist might expect from the reaction of tissues to foreign bodies of certain chemical or physical properties.

A very valuable chapter is devoted to fluoroscopic endoscopy in which the biplane fluoroscope is used to great advantage.

The book is filled with valuable axioms learned from years of clinical experience and over 3,000 cases of foreign body in the air and food passages. Written from such a large store of material it deserves high praise for concrete knowledge it discloses and its quality will give it more than a temporary success.

JOHN F. DELPH.

IN the third edition of Slemons' book[2] on the prospective mother changes have been made in many subjects, especially: the arrangement of the diet, the gain in weight during pregnancy; the employment of the X-ray for greater accuracy of diagnosis; the rôle of the endocrine glands in the menstrual cycle; and the modern methods of anæsthesia at the time of birth.

The reviewer has never believed that pregnant women should be told as much of the anatomy and physiology of pregnancy and labor as this book discloses. The smattering of information which the patient obtains is apt to be misapplied and misinterpreted.

Teachers of obstetrics realize how difficult it is for medical students to grasp the normal in obstetrics. What sort of grasp will the layman get in this short course in obstetrics?

The rest of the information is well given.

In the reviewer's opinion, all the information a lay woman needs on the subject of the prospective mother could be stated in fewer than 311 pages; many obstetricians find a booklet of 16 to 20 pages ample.

To those who do not agree with him, the reviewer recommends this as a good book.

EDWARD L. CORNELL.

THE discovery of the sympathetic nervous system by the surgeon has been a recent affair, though the neuro-anatomist and physiologist have been contributing for many years to our knowledge of this regulator of our body's internal economy. Like most fundamental discoveries in science the facts set forth by these experimentalists became general property only when it was shown that somehow and in some way the involuntary control over our blood vessels, glands, and viscera might be influenced by various surgical operations.

So rapid was this invasion of a new surgical field that many procedures were advocated which opposed all known anatomical or physiological facts. In truth, it was only after several years, during which the literature was crowded with publications, that surgeons found that many times they did not fully understand one another. So we find them now solemnly emphasizing that by the "sympathetic system," they mean that part of the autonomic nervous system represented in the thoracico-lumbar outflow. Familiarity with the known facts in the beginning might have made surgical progress more sure and perhaps less bombastic.

During the last 10 years claims for the relief of the spasticity of muscles following lesions of the central nervous system have been disproven step by step. Recently, the careful reporting of observations upon patients operated upon for vascular diseases of the extremities has added to the scientific data which must be balanced in the final judgment upon operations designed to give much needed relief to unfortunate patients. It is unfortunate that the critical, unprejudiced judgment of the laboratory worker is not always employed by the surgeon in evaluating the results of his operations. Surely, it is not enough to say empirically, "the patient says he feels better."

Early in their book,[3] Gask and Ross lead one to believe that their evaluation of the surgery of the sympathetic nervous system is to be a critical one. Unfortunately they do not hew to the line throughout; for example, their acceptance of Lewis' contention that removal of the sympathetic supply to an extremity does not prevent the occurrence of attacks of vasoconstriction in Raynaud's disease. Careful examination of surface temperature changes properly

[1] ANNALS OF ROENTGENOLOGY; A SERIES OF MONOGRAPHIC ATLASES. Edited by James T. Case, M.D. Vol. XVI—FOREIGN BODY IN AIR AND FOOD PASSAGES. By Chevalier Jackson, M.D., and Chevalier L. Jackson, M.D. New York: Paul B. Hoeber, Inc., 1934.

[2] THE PROSPECTIVE MOTHER; A HANDBOOK FOR WOMEN DURING PREGNANCY. By J. Morris Slemons, M.D. New York: D. Appleton-Century Co., Inc., 1934.

[3] THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM. By George E. Gask, C.M.G., D.S.O., F.R.C.S.(Eng.), and J. Paterson Ross, M.S.(Lond.), F.R.C.S.(Eng.). Baltimore: William Wood & Co., 1934.

controlled and of blood volume changes in the fingers will support that view. These are the facts which the surgeon can add which will be of some ultimate value. It is surprising that the authors, after pointing out correctly that the assumption on which periarterial sympathectomy was based is incorrect, devote so much space to the subject and do not insist upon an evaluation of the claimed clinical results similar to those employed by Lewis in his study of the results of operations for Raynaud's disease. Again, we read: "It would be unwise to advocate this operation (periarterial sympathectomy) in the treatment of Raynaud's disease or thromboangiitis obliterans, though occasionally an astonishing improvement may occur in the latter disease."

The strongest argument for periarterial sympathectomy would seem to be the statements that pain of vascular origin is relieved. Certainly, it should be pointed out that not all cases of causalgia can be relieved by such an operation. Inasmuch as the nerve supply to the vessels of an extremity is segmental, and since it has been shown that there is no pathway for afferent painful impulses along the course of the vessels, it is difficult to understand how the pathway is broken unless by chance the operation is performed above the site of the lesion the exact nature or location of which is commonly unknown.

It is disappointing that the battle between their obvious sense of the application of physiological criteria to the results of their operations and their surgical belief that some clinical good must come of an operation for which they have no scientific factual basis, should have led the authors to champion surgical procedures rather than record their results in graphic data which could be interpreted by their readers. For example, does a patient with removal of the periarterial nerve supply to the radial or brachial artery respond to a stimulus of the lumen of that vessel below the site of the operation?

Finally, that the authors realize the necessity for keeping an open but critical mind on this entire business of the surgical attack upon the sympathetic nervous system is obvious in their last sentence. ". . . until more is known about the pathology of the sympathetic system, the place of surgery in the treatment of its disorders cannot be firmly established." L. D.

THE author of this monograph, Dr. McIver, has presented a remarkably clear and comprehensive picture of the problem of acute intestinal obstruction from both the clinical and experimental viewpoint.[1] It is the best analysis that has yet appeared and deserves a place with the classic papers in this field. The author and his associates have made a very important and fundamental contribution to our knowledge of the cause of death in acute intestinal obstruction, but this achievement has by no means blinded him to the work of others. He is thoroughly acquainted with the voluminous literature and very few worth while contributions have escaped his critical survey. The first section of the book gives a general picture of the disease and a discussion of the underlying pathological lesions responsible for various types of mechanical obstruction. The importance of the level of the obstruction and the condition of the circulation in the mesentery and intestine is emphasized. There is a thorough discussion of the symptomatology and an excellent summary of the changes in the chemistry of the blood and in the body fluids, a field in which the author has made such a signal contribution.

The diagnosis of acute obstruction is based upon the clinical symptoms and upon X-ray examination, with or without a barium enema. Laboratory studies are usually of little aid, since changes in the blood chemistry may not be present in some cases, and appear too late in many others. The section on treatment emphasizes the necessity of prompt operative intervention. While the replacement of fluid and restoration of the altered blood chemistry is important, operation must not be too greatly delayed on this account. Decompression of the stomach and the obstructed intestine by means of a duodenal tube with moderate suction is described. The author, however, wisely reserves judgment regarding the general applicability of this method and is concerned lest its adoption postpone surgical treatment.

The surgical treatment of acute intestinal obstruction is thoroughly described and the usefulness of enterostomy is emphasized. The sections on preoperative and postoperative treatment and the methods of handling high intestinal fistulæ and other similar complications are especially instructive.

The last section contains an excellent critical summary of the experimental work that has been done to determine the cause of death. The relative significance of dehydration, due to loss of the various digestive secretions, and toxæmia, due to absorption from the proximal intestine, in obstructions at various levels in the gastro-intestinal tract and with varying degrees of circulatory interference to the bowel wall is ably presented and the conclusions drawn are logical in the light of present knowledge. Every general surgeon and everyone interested in the problem of intestinal obstruction from the experimental standpoint should read this book.

LESTER R. DRAGSTEDT.

THE first edition of Stokes' excellent monograph on syphilology was published in 1926. In the second edition,[2] the book has been enlarged and 15 of the 23 chapters have been rewritten. A new chapter on relapse and progression is another improvement.

The first edition had, as a definite aim, the presentation of the subject to the completely uninitiated

[1] HOEBER'S SURGICAL MONOGRAPHS: ACUTE INTESTINAL OBSTRUCTION. By Monroe A. McIver, M.D. New York: Paul B. Hoeber, Inc., 1934.

[2] MODERN CLINICAL SYPHILOLOGY; DIAGNOSIS, TREATMENT, CASE STUDIES. By John H. Stokes, M.D. 2d ed. rev. Philadelphia and London: W. B. Saunders Co., 1934.

student and practitioner in such a manner that he could school himself from first to last in the practice of modern syphilology, and, next, to provide the more expert with an authoritative reference work.

In this new work the author has ably preserved these objectives and in addition has compiled a most complete review of the literature. Every essential advance in our knowledge of this subject is ably presented.

The book is exceptionally well written, and the author has utilized well the enormous statistical material obtained from the co-operative clinical group of five American university syphilis clinics working in co-operation with the United States Public Health Service. This material embraces the records of 75,000 cases of syphilis in all its aspects.

The chapters on treatment have been rewritten and revised and much new material added, including a comparative appraisal of the various arsphenamines, a section on acetarsone, and a valuable dissertation on tryparsamide.

Cardiovascular syphilis, neurosyphilis, prenatal and congenital syphilis are all adequately and very interestingly treated. There are 973 excellent illustrations and case records. These cases are presented just as they would be in a clinic. The author first points out the salient diagnostic points in the illustration and then discusses the case fully, pointing out essential facts in differentiating it from other conditions with which it might be confused. These illustrations and case records are a most valuable means of teaching the subject to the student and should make this work almost indispensable for the general practitioner.

There is no book today that covers the subject of syphilis so completely and so authoritatively as does this new work of Stokes. One wonders how any one man even with help could have had the courage and the ability to tackle this enormous task.

It is a work that should be unhesitatingly recommended to every general practitioner and student of medicine. I know of no book that can be of more practical value. The book is printed in large readable type. The binding is well done, and the work is a credit to the author and publishers.

EDWARD A. OLIVER.

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

THE PRACTITIONER'S LIBRARY OF MEDICINE AND SURGERY. Vol. vii—Pediatrics. New York and London: D. Appleton-Century Co., 1935.

MEDICAL TACTICS AND LOGISTICS. By Colonel Gustavus M. Blech and Colonel Charles Lynch. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1934.

THE CLINICAL ASPECTS OF VISCERAL NEUROLOGY; WITH SPECIAL REFERENCE TO THE SURGERY OF THE SYMPATHETIC NERVOUS SYSTEM. By W. K. Livingston, M.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1935.

PRACTICAL ENDOCRINOLOGY; SYMPTOMS AND TREATMENT. By Max A. Goldzieher, M.D. New York and London: D. Appleton-Century Co., 1935.

THROUGH THE PATIENT'S EYES; HOSPITALS—DOCTORS—NURSES. By Sister John Gabriel, R.N., A.B. Philadelphia, London, Montreal: J. B. Lippincott Co., 1935.

HIDATIDOSIS OSEA. By Dr. Oscar Ivanissevich. Buenos Aires: Imprenta Amorrortu, 1934.

DISEASES OF THE RECTUM AND COLON AND THEIR SURGICAL TREATMENT. By J. P. Lockhart-Mummery, F.R.C.S. (Eng.), M.A., M.B., B.C.Cantab. 2d ed. Baltimore: William Wood & Co., 1934.

ANNUAL REPORT OF THE SURGEON GENERAL OF THE PUBLIC HEALTH SERVICE OF THE UNITED STATES FOR THE FISCAL YEAR 1934. Washington: United States Government Printing Office, 1934.

STANDARD CLASSIFIED NOMENCLATURE OF DISEASE. Compiled by The National Conference on Nomenclature of Disease. Edited by H. B. Logie, M.D., C.M. New York: The Commonwealth Fund, 1935.

THE CYCLOPEDIA OF MEDICINE. Edited by George Morris Piersol, B.S., M.D., and Edward L. Bortz, A.B., M.D. Vol. 12. Philadelphia: F. A. Davis Co., 1934.

ELEVENTH SCIENTIFIC REPORT ON THE INVESTIGATIONS OF THE IMPERIAL CANCER RESEARCH FUND. Under the direction of the Royal College of Physicians of London and the Royal College of Surgeons of England. Published by the authority of the Executive Committee. London: Taylor and Francis, 1934.

SUPPLEMENT TO THE ELEVENTH SCIENTIFIC REPORT ON THE INVESTIGATIONS OF THE IMPERIAL CANCER RESEARCH FUND. Under the direction of the Royal College of Physicians of London and the Royal College of Surgeons of England. Published by the Authority of the Executive Committee. The filterable tumours of fowls: a critical review. By L. Foulds. London: Taylor and Francis, 1934.

THIRTY-SECOND ANNUAL REPORT 1933–1934 OF THE IMPERIAL CANCER RESEARCH FUND. Under the direction of the Royal College of Physicians of London and the Royal College of Surgeons of England. November, 1934.

VOLUNTARY STERILIZATION. By C. P. Blacker, M.C., M.A., M.D., M.R.C.P. London: Oxford University Press, 1934.

MODERN OPERATIVE SURGERY. Edited by G. Grey Turner, M.S., F.R.C.S.(Eng.), F.A.C.S.(Hon.). Vols. i and ii. 2d ed. Baltimore: William Wood & Co., 1934.

HANDBUCH DER GYNAEKOLOGIE. 3d rev. enl. ed. Edited by W. Stoeckel. Vol. viii, third part—Die gonorrhoische Infektion der Genitalorgane. By C. Bucura. Munich: J. F. Bergmann, 1934.

SUMMARY OF THE TREATMENT OF FRACTURES AND DISLOCATIONS. By R. Broomhead, M.B., F.R.C.S. Leeds: Jowett & Sowdry, Ltd.

LEZIONI DI CLINICA CHIRURGICA (RAFFAELE PAOLUCCI). Prepared by Dott. Eugenio Bernabeo. Bologna: Nicola Zanichelli, 1934.

REPORT ON SEVENTH INTERNATIONAL CONGRESS OF MILITARY MEDICINE AND PHARMACY AND MEETINGS OF THE PERMANENT COMMITTEE. Madrid, Spain, May 29–June 3, 1933. By Captain William Seaman Bainbridge, M.C.F., U.S.N.R. Menasha, Wisconsin: The Collegiate Press; George Banta Publishing Co.

THE TREATMENT OF COMMON FEMALE AILMENTS. By Frederick John McCann, M.D.(Edin.), F.R.C.S., F.C.O.G., M.R.C.P.(Lond.). 3d ed. Baltimore: William Wood & Co., 1934.

POLIOMYELITIS; A HANDBOOK FOR PHYSICIANS AND MEDICAL STUDENTS; BASED ON A STUDY OF THE 1931 EPIDEMIC IN NEW YORK CITY. By John F. Landon, M.D., and Lawrence W. Smith, M.D. With a section on the orthopedic after care of the disease by Garry DeN. Hough, Jr., M.D., F.A.C.S., F.A.A.O.S. New York: The Macmillan Co., 1934.

HEAD INJURIES. By L. Bathe Rawling, M.B., B.Ch., F.R.C.S. New York and London: Oxford University Press, 1934.

CLINICA QUIRURGICA. By Pablo L. Mirizzi. Tomo 4. Córdoba: El Aleneo, 1934.

A SYNOPSIS OF SURGICAL ANATOMY. By Alexander Lee McGregor, M.Ch.(Edin.), F.R.C.S.(Eng.). With a foreword by Sir Harold J. Stiles, K.B.E., F.R.C.S.(Edin.). 2d ed. Baltimore: William Wood & Co., 1934.

BEE VENOM THERAPY; BEE VENOM, ITS NATURE, AND ITS EFFECT ON ARTHRITIC AND RHEUMATOID CONDITIONS. By Bodog F. Beck, M.D. New York and London: D. Appleton-Century Co., Inc., 1935.

A BRIEF OUTLINE OF MODERN TREATMENT OF FRACTURES. By H. Waldo Spiers, A.B., M.D. Baltimore: William Wood & Co., 1935.

A TEXTBOOK OF SURGERY; FOR STUDENTS AND PHYSICIANS. By W. Wayne Babcock, A.M., M.D., LL.D., F.A.C.S. 2d ed. Philadelphia and London: W. B. Saunders Co., 1935.

PRACTICAL NEUROLOGICAL DIAGNOSIS; WITH SPECIAL REFERENCE TO THE PROBLEMS OF NEUROSURGERY. By R. Glen Spurling, M.D. Springfield, Ill. and Baltimore, Md.: Charles C. Thomas, 1935.

ILLUSTRATIVE ELECTROCARDIOGRAPHY. By Joseph H. Bainton, A.B., M.D., and Julius Burstein, A.B., M.D. New York and London: D. Appleton-Century Co., Inc., 1935.

MANOBRAS E OPERACOES OBSTÉTRICAS (EXTRA E TRANSPELVICAS). By Dr. João Pereira de Camargo. 2d enl. rev. ed. Rio de Janeiro: Livraria Francisco Alves, 1935.

THE PATIENT AND THE WEATHER. By William F. Petersen, M.D. With the assistance of Margaret E. Milliken, S.M. Volume ii—Autonomic Dysintegration. Ann Arbor, Michigan: Edwards Brothers, Inc., 1934.

X-RAY INTERPRETATION. By H. Cecil H. Bull, M.A., M.B., M.R.C.P. London: Oxford University Press, 1935.

ELEMENTARY HUMAN ANATOMY; BASED ON LABORATORY STUDIES. By Katharine Sibley. New York: A. S. Barnes & Co., 1935.

INDICATIONS ET CONTRE-INDICATIONS DU TRANSPORT PAR AVION DANS LES AFFECTIONS CHIRURGICALES DE L'ABDOMEN, DU THORAX ET DU CRANE. By Docteur Jean Leduc. Saint-Quentin, France: Imprimerie Moderne, 1934.

CORRESPONDENCE

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